00393

MAINTENANCE MANUAL

INSTRUMENT REPAIR SERVICE, INC.
3145-A GATEWAY DRIVE
NORCROSS, GEORGIA 30071
(404) 447-6666

INSTRUMENT REPAIR SERVICE, INC.
7519 Currency Drive
Orlando, Florida 32809
(305) 855-5291

CE-21A FREQUENCY SELECTIVE LEVELMETER

Cushman
Electronics, Inc.

CE-21A
FREQUENCY SELECTIVE
LEVELMETER

MAINTENANCE MANUAL

CUSHMAN
ELECTRONICS, INC.
830 Stewart Dr · Sunnyvale, CA 94086
Telephone: Area Code 408 – 739-6760

5601••0046

October 1973

CUSHMAN ELECTRONICS, INC.

MANUAL CHANGE NOTICE

INSTRUMENT CE-21A MANUAL NO. 5601-0046 DATE PRINTED OCT. 1973

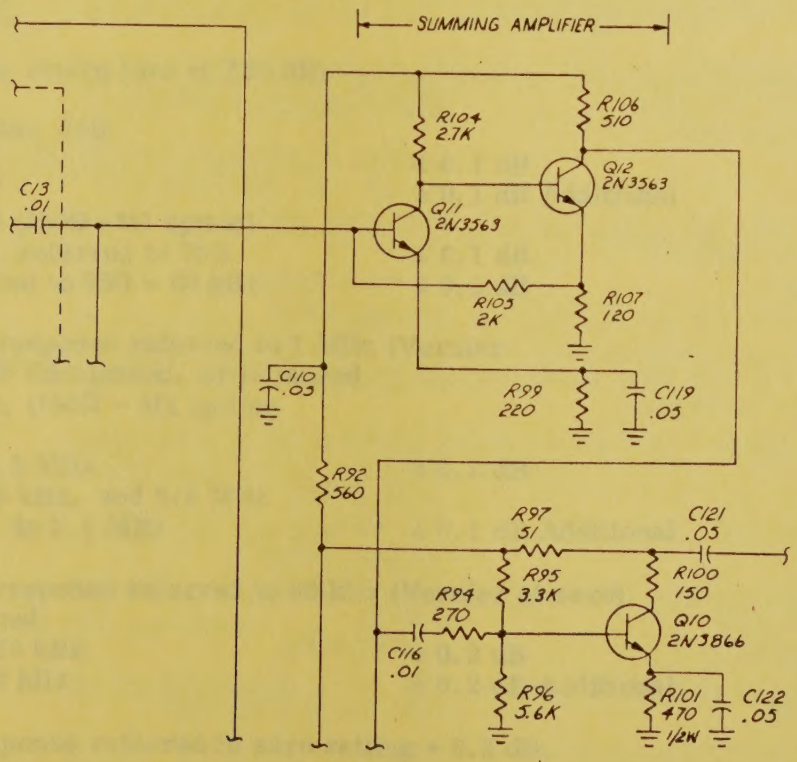
The following changes are necessary to bring your manual up to date. Changes are listed with the instrument serial numbers to which they apply. It is suggested that you enter these changes in your manual immediately.

Serial number 161 and up.

Parts list, Voltage Controlled Oscillator, 2300, p. 3-36, delete IC1, 901CE UHF Linear Amplifier. P. 3-38 add resisitors and transistors as follows:

R104	Comp, 2.7K, ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R105	Comp, 2K, ±5%, 1/4W	1066-2025	Allen-Bradley	CB2025
R106	Comp, 510Ω, ±5%, 1/4W	1066-5115	Allen-Bradley	CB5115
R107	Comp, 120Ω, ±5%, 1/4W	1066-1215	Allen-Bradley	CB1215
Q11	Si, NPN, 2N3563	1272-0022	Fairchild	2N3563
Q12	Si, NPN, 2N3563	1272-0022	Fairchild	2N3563

Schematic Diagram, Figure 3-6, Voltage Controlled Oscillator, 2300, p. 3-39, delete IC1 and add resisitors, R104 2.7K, R105 2K, R106 510, R107 120, and transistors Q11, Q12, 2N3563 as shown below:



5614-0028

Date Sept. 1976

CUSHMAN ELECTRONICS, INC.

MANUAL CHANGE NOTICE

INSTRUMENT CE-21A MANUAL NO. 5601-0046 DATE PRINTED Oct, 1973

The following changes are necessary to bring your manual up to date. Changes are listed with the instrument serial numbers to which they apply. It is suggested that you enter these changes in your manual immediately.

All serial numbers.

Change Notice dated July 1975, sheet 7, Table 1-1, Specifications, CE-21A, delete section labeled FREQUENCY and insert the following:

FREQUENCY

Range	10 kHz to 9.1 MHz
Digital Resolution	1 kHz
Vernier Range	1.1 kHz
Vernier Resolution	25 Hz
Accuracy	±200 Hz from 0°C to +50°C
Aging	≤150 Hz per year

Delete paragraph labeled ACCURACY and insert the following:

ACCURACY

(with source return loss of ≥30 dB)

1 MHz-0 dBm, 75Ω	
25°C ± 10°C	± 0.1 dB
25°C ± 25°C	± 0.1 dB Additional
124Ω, 135Ω (150Ω -M1 option) referred to 75Ω	± 0.1 dB
600Ω referred to 75Ω - 60 kHz	± 0.1 dB

Frequency response referred to 1 MHz (Vernier at zero) 75Ω Unbalanced, or Balanced 124Ω, 135Ω, (150Ω - M1 option)

60 kHz to 8.5 MHz	± 0.2 dB
10 kHz to 60 kHz, and 8.5 MHz to 9.1 MHz	± 0.1 dB Additional

Frequency response referred to 60 kHz (Vernier at zero)
600Ω Balanced

60 kHz to 650 kHz	± 0.2 dB
10 kHz to 60 kHz	± 0.2 dB Additional

Vernier response referred to zero setting + 0.3 dB.

Attenuator referred to 0 dBm + 0.25 dB.

CE-21A Maintenance Manual, Section 2, Maintenance delete pages 2-1, 2-2, 2-4, 2-5, 2-6, 2-7 and substitute the following:

GENERAL

2.01 This section of the manual contains the information necessary to check the performance and to adjust and calibrate the CE-21A Frequency Selective Levelmeter.

2.02 The performance checks may be used to verify proper operation or as an incoming inspection check. Adjustment and calibration procedures should be carried out only if out of tolerance operation is observed.

2.03 If the Adjustment procedures fail to correct the difficulty, and the cause of the trouble is not readily apparent or cannot conveniently be repaired, it is recommended that the faulty circuit board or the whole instrument be returned to the factory or to a service center for repair. Always contact the Cushman Electronics Customer Service Department before returning equipment or shipping it to a Service Center. See paragraph 2.62.

2.04 The CE-21A should be turned on and warmed up for at least one hour before beginning the Performance checks or the Adjustment and Calibration procedures.

PERFORMANCE CHECK

2.05 TEST EQUIPMENT REQUIRED

Signal Generator	Cushman CE-26A or equivalent
Electronic Counter	Dana 8100 or equivalent
1 MHz Low Pass Filter	Cirqtel FLT21B-1-5/75-3A/3B (30 dB min. attenuation at 2 MHz or equivalent)
60 dB Variable RF Attenuator	Daven 10240C-75-60-7 BNC or equivalent

2.06 Set the CE-21A front panel controls as listed below. Changes will be indicated for procedures as necessary.

METER	EXP
MODE	LOW NOISE
IMPEDANCE	75 OHMS
INPUT	TERM, UNBAL
LEVEL	-0.0 dBm
BANDWIDTH	200 Hz
FREQUENCY	1.0000 MHz
AUDIO	AM
VOLUME	Just out of PWR OFF

2.07 Set the CE-26A controls as follows:

OUTPUT SWITCH	ON
LEVEL	0.0 dBm
FINE	Set METER to 0 dB
FREQUENCY	1.0000 MHz
TUNING	INT
OUTPUT IMPEDANCE	75Ω Unbalanced

2.08 MEASUREMENT ACCURACY

2.09 Connect the 75Ω UNBAL output of the CE-26A to the 75Ω UNBAL input of the CE-21A.

a. Depress the PUSH TO CAL button on the CE-21A and adjust the 100 Hz dial for a maximum meter reading.

b. Adjust the CAL control on the CE-21A for a 0.0 dB reading on the meter.

c. Depress the PUSH TO CAL switch to release it. Adjust 100 Hz dial on the CE-26A for a maximum meter reading. The meter should read 0.0 dB ±0.1 dB on the lower scale.

d. Depress the METER NORM switch. The meter should read 0.0 dB ± 0.1 dB on the upper scale.

2.10 FREQUENCY RESPONSE

2.11 Depress the EXP switch on the CE-21A and adjust the CAL control for 0.0 dB on the meter.

a. Set the FREQUENCY on both the CE-21A and CE-26A to 100 kHz and adjust the CE-26A Frequency Vernier for maximum reading. Meter should read 0.0 dB ±0.2 dB.

b. Repeat step a. at 4.1 MHz and 9.1 MHz. At 9.1 MHz the meter should read 0.0 dB ±0.3 dB.

2.12 FREQUENCY ACCURACY

2.13 With the CE-26A still connected to the CE-21A, monitor the output frequency of the CE-26A with a counter.

a. Set the frequency of the CE-21A and the CE-26A to 100 kHz.

b. Adjust the 100 Hz dial on the CE-21A for a maximum reading on the meter. The frequency indication on the CE-21A should be 100 kHz ±200 Hz.

c. Repeat steps a. and b. at 9.1 MHz. Disconnect counter.

2.14 ATTENUATOR ACCURACY

2.15 Set the CE-21A and CE-26A Frequency to 1.0 MHz. Connect RF Variable Attenuator, set to 0.0 dB attenuation, between CE-26A and CE-21A.

a. Adjust CE-21A 100 Hz dial for a maximum reading on the CE-21A. Adjust the CAL control for a 0.0 dB reading on the CE-21A meter.

b. Set the CE-21A control to +10 dBm and set the CE-26A level to +10 dBm (+9 dB on dial and + 1 dB on meter). The CE-21A meter should read 0.0 dB ± 0.25 dB.

c. Set the CE-26A to -1 dBm (meter to 0.0 dB and dial to -1 dB). Set the CE-21A dB1 to -0 dBm and dB2 to -1 dBm. CE-21A meter should read 0.0 dBm ±0.25 dB.

d. Repeat step c. setting CE-26A and CE-21A dB2 dials to each 1 dB step between -1 and -9 dBm. CE-21A meter should read 0.0 dBm ±0.25 dB at each step.

e. Set CE-21A dB1 to -0 dBm and dB2 to -10 dBm. Set CE-26A to -10 dBm. The CE-21A meter should read 0.0 dBm ±0.25 dBm.

f. Repeat step e. adjusting CE-21A dB2 and CE-26A Level to each 10 dB step between -10 and -90 dBm. For the three 10 dB steps below -60 dBm set the CE-26A to -60 dBm and set the Variable RF Attenuator to 10, 20 and 30 dB as necessary. CE-21A meter should read 0.0 dB ±0.25 dB at each step.

ADJUSTMENT AND CALIBRATION

2.16 TEST EQUIPMENT REQUIRED

Digital Multimeter	Dana 4300 or equiv.
Electronic Counter	Dana 8100 or equiv. (Must have input sensitivity or 10 mV or better)
RF Voltmeter	Boonton 91D or equiv.
AC Voltmeter	HP400FL or equiv.
Sig. Generator	Cushman CE-26A or equiv.
Sig. Generator	HP606A or equiv.
Feedthru 75Ω Termination	Texscan FP-75 BNC or equiv.
60 dB Variable RF Attenuator	Daven 10240C-75-60-7 BNC or equivalent
1 MHz Low Pass Filter	(30 dB Rejection at 2 MHz) Cirqtel FLT 21B-1-5/75-3A/3B or equivalent
50/75Ω Matchin Pad	Texscan ZM-57 or equiv.

2.17 CONTROL SETTING

METER	NORM
PUSH TO CAL	OUT (Normal Operation)
LEVEL dB1	-0 dB
dB2	-0 dB
FREQUENCY	1.0000 MHz
MODE	LOW NOISE
BANDWIDTH	2.3 kHz
IMPEDANCE	TERM, 75Ω, UNBAL
AUDIO	AM
VOL	Just out of PWR OFF

2.18 Turn on the CE-21A and warm up for at least an hour before beginning adjustment procedures. CAUTION NOTE: Always turn off AC power before removing or installing a circuit board. Remove the top and bottom covers.

2.19 POWER SUPPLY

2.20 Measure power supply voltages at J2007 (2800) on top of main chassis, +20V at pin V, 18, +5V at pin R, 14, -12V at pin N, 12. Voltages must be ±0.5V. If adjustment is necessary always adjust +20V first. R2807 adjusts +20V, R2825 adjusts +5V, R2845 adjusts -12V. SEE FIGURES 2-1.

2.21 VOLTAGE CONTROLLED OSCILLATOR

2.22 Elevate the 2400 board (Sample & Hold) on extender. Set DMM for DC and connect to TP7 on the 2400 board.

a. Dial in 0.999 MHz on the FREQUENCY selector. Meter should read 13.0V ±0.1V. If necessary adjust L2302 (12 MHz coil) for this reading. SEE FIGURE 2-1.

b. Dial in 1.999 MHz. Adjust L2303 (13 MHz coil) for a 13.0V ±0.1V reading.

c. Follow the same procedure for 2.999 MHz, L2304; 3.999 MHz, L2305; 4.999 MHz, L2306; 5.999 MHz, L2307; 6.999 MHz, L2308; 7.999 MHz, L2309; 9.100 MHz, L2310. DMM reading must be 13.0V ±0.1V for each setting.

d. Dial in 8.000 MHz. Reading should be 4.5V ±.7V.

e. Follow same procedure (d.) for 7.000, 6.000, 5.000, 4.000 MHz, 3.000 MHz, 2.000 MHz, 1.000 MHz, 0.000 MHz. Reading should be 4.5V ±.7V. Replace 2400 board.

2.23 PRELIMINARY GAIN SET

2.24 Set controls as in para. 2.17 except set LEVEL to -70 dBm, FREQUENCY to 1.000 MHz and BANDWIDTH to 200 Hz.

a. Center CAL control.

b. Set CE-26A to 1.000, -70 dBm (-69 on dial and -1 dB on meter) and connect 75Ω UNBAL output to CE-21A UNBAL input.

c. Tune for maximum meter reading with 100 Hz dials on CE-26A.

d. Adjust R2533 for 0 dB ±0.1 dB on the CE-21A meter.

2.25 FIRST MIXER BALANCE

2.26 Set controls as in para. 2.17 Except FREQUENCY to 9.9 kHz.

a. Disconnect any signal from INPUT.

b. Decrease setting of 1 kHz dial until a reading appears on the meter.

c. Very carefully adjust C3103 and R3106 for a minimum reading on the meter. Access holes to these adjustments are on the RF casting toward the front on the inside.

d. Increase the meter reading by adjusting the 1 kHz and 100 Hz dials. Continue to adjust C3103 and R3106 for a minimum reading on the meter until the lowest null is reached. It should be possible to bring the meter below full scale for a 2 kHz FREQUENCY setting.

2.27 100 Hz DIAL

2.28 Set controls as in para. 2.17.

a. Connect counter to J4009 (red C, black E) on rear panel. Use 12 MHz amplifier if necessary.

b. With 100 Hz dial set to "0" adjust R2605 (0 Hz) (see Figure 2-1) until counter reads 11.9200 MHz ±50 Hz.

c. Set 100 Hz dial to "9" and adjust R2602 (900 Hz) until the counter reads 11.9191 MHz ±50 Hz.

d. Repeat steps b. and c. until no further adjustment is required.

e. Check with dial set at 5 and -1, counter should read 11.9195 ±50 Hz and 11.9201 ±50 Hz respectively.

f. Disconnect counter from J4009 and connect RF voltmeter (using 50 ohm probe) in its place. Output level should be 13mV ±3 mV. Adjust L3702 (bottom of RF casting) for maximum reading.

2.29 PRELIMINARY MASTER OSCILLATOR ADJUST

2.30 Set FREQUENCY to 9.100 MHz

a. Connect counter to J4008 (red B, black D).

b. Adjust C2134 (see figure 2-1) until counter reads 21.100 MHz ±5 Hz.

c. Set FREQUENCY to 0.000 MHz. Counter should read 12.000 MHz ± 5 Hz.

d. Connect RF voltmeter to J4008 in place of counter, output level should be 50 mV ±15mV.

e. Connect RF voltmeter to J4007 (red A, black C). Output level should be 360 mV ±30 mV.

2.31 BANDWIDTH SELECTOR

2.32 Set CE-21A controls as in para. 2.17 except set meter to EXP, BANDWIDTH to 200 Hz, FREQUENCY to 999.0 kHz.

a. Set CE-26A to 0 dBm, 999.0 kHz, 75 ohm UNBAL and connect to UNBAL input of CE-21A.

b. Tune the 100 Hz dial on the CE-21A for maximum meter reading and set to 0 dB with the CAL control.

c. Switch BANDWIDTH to 2.3 kHz and adjust R2523 for a 0 dB ± .1 dB meter reading.

d. Switch back to 200 Hz BANDWIDTH.
Reset frequency on both instruments to 0999.4 kHz and fine tune CE-21A with 100 Hz dial for a peak reading.

e. Adjust CAL control for a +1 dBm reading on the meter.

f. Slowly adjust frequency of generator for -3 dB points on both sides of maximum. Ripple should be less than 0.2 dB. Bandwidth should be 200 Hz ± 20 Hz. Switch to 2.3 kHz Bandwidth.

g. Tune generator and observe the frequency at the -3 dB points. Bandwidth should be 2.3 kHz ± 230 Hz.

2.33 METER AMPLIFIER

2.34 Set CE-21A controls as in para. 2.17 except set LEVEL to -70 dBm, FREQUENCY to 999 kHz.

a. Set CE-26A to -70 dBm and 999 kHz. Connect 75 ohm UNBAL output to CE-21A, 75 ohm UNBAL input.

b. Adjust for meter reading of 0 dBm with CAL control.

c. Set METER to EXP position. Adjust R2233 (zero) for a 0 dBm reading on the meter.

d. Set CE-26A LEVEL to -72 dBm. Adjust R2231 (GAIN) for -2 dBm meter reading and repeat c and d until both conditions are met.

e. Set CE-26A LEVEL to -68 dBm. Meter should read +2 dBm ± 0.03 dB.

2.35 CAL LEVEL

2.36 Set controls as in para. 2.17 except set METER to EXP and BANDWIDTH to 200 Hz.

a. Set CE-26A to 1.000 MHz, 0 dBm, 75 ohms, and connect UNBAL output to CE-21A, 75 ohms UNBAL input.

b. Peak reading on meter with CE-21A 100 Hz dial. Set CAL control mark to line on front panel (straight up).

c. Adjust R2533 (GAIN). See Figure 2-1, for 0 dB on the EXP meter scale.

d. Depress PUSH TO CAL switch and tune for a peak reading on the meter with the CE-21A 100 Hz dial.

e. Adjust R2450 (CAL) for a 0 dB reading on the EXP meter scale.

2.37 MASTER OSCILLATOR ADJUST

2.38 Replace covers on CE-21A and allow to warm up for at least an hour. Repeat step 2.30 for the final Master Oscillator adjustment.

TROUBLESHOOTING

2.39 When trouble is experienced make sure of AC power to instrument, that power fuse is OK, that dial lights are on. If dial lights are not on be sure the PUSH TO CAL switch is in the out position.

a. Make sure that all controls are set in their proper position. Make certain signal is plugged into the proper jack and that input controls are properly set.

b. For further checks refer to the troubleshooting chart Table 2-1.

c. If another CE-21A is available a quick way to localize trouble is by board substitution.

d. When trouble is localized the defective board or the complete instrument may be returned to the factory for repair.

Always contact the Cushman Electronics Customer Service Department before returning parts or instrument. See paragraph 2.62.

2.40 FUSES

2.41 The main fuse, 3A SLO BLO, is mounted on the rear panel and is accessible from the outside of the instrument. Each of the power supplies is individually fused. The fuses are mounted on the power supply board, 2600, which is mounted on the right side of the inner chassis. The fuses are, from front to rear, +5V, -12V, +20V. The +20V and -12V are 1A SLO BLO and the +5V fuse is 2A SLO BLO. If one of these fuses should blow, check the power supply circuits to determine the cause before again turning on the AC power. Approximate resistances to ground, with AC power disconnected, at the DC test point, see paragraph 2.20, on the Power Supply Regulators board are: +20V approximately 90 ohms, +5V approximately 30 ohms. Resistances may vary considerably with type of ohmmeter and polarity of test leads.

Page 8, delete paragraphs 2.56, 2.57 and replace with the following (2.44-2.57 blank):

OPERATIONAL CALIBRATION

2.42 Calibration of the CE-21A is semiautomatic. When the PUSH TO CAL switch is depressed the input circuit is switched to 75 ohms, an internally generated calibration signal is provided, the frequency of the 1st LO is preset for 1 MHz and the sttenuators are adjusted for a 0 dBm input. The meter is then manually set to zero. This calibrates the instrument for all available input impedances and for all frequencies within the range of the CE-21A.

2.43 Perform the following steps:

a. Depress the PUSH TO CAL switch.
All the LEVEL and FREQUENCY readouts are now darkened except the 100 Hz frequency control.

b. Depress the LOW NOISE, the 200 Hz BANDWIDTH, and the METER EXP switches.

c. Rotate the 100 Hz frequency control until a peak reading is obtained on the meter.

d. Zero the meter on the EXP meter scale by adjusting the control below the PUSH TO CAL switch.

e. Depress the METER NORM switch. The reading on the upper meter scale should be 0 dB ±0.1 dB.

f. Depress the 2.3 kHz BANDWIDTH switch. The meter reading should be ±0.1 dB of reading in step e.

g. Depress the PUSH TO CAL switch to release it. The instrument is now ready for use.

NOTE 1: In the LOW NOISE mode 20 dB of attenuation is switched out of the input circuit and 20 dB attenuation is switched into the IF to give the best signal-to-noise ratio. In the LOW DISTORTION mode 20 dB attenuation is switched into the input circuit and 20 dB attenuation is switched out of the IF. The purpose of the LOW DISTORTION mode is to prevent the input mixer from being overloaded by adjacent channel signals, particularly when making idle channel noise measurements. When the meter pins with a slight increase in sensitivity this is an indication of overload. Below -79 dBm the condition is the same for either mode since the 20 dB IF attenuation must be removed to obtain this sensitivity.

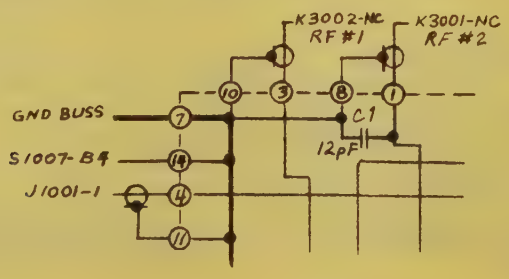
NOTE 2: Whenever the CE-21A is placed in the LOW DISTORTION mode the meter will show small random fluctuations due to the reduced signal-to-noise ratio in this mode. Accuracy is slightly reduced due to these fluctuations.

NOTE 3: When the instrument is to be used in the LOW NOISE mode, calibration should be performed in the LOW NOISE mode. When the instrument is to be used in the LOW DISTORTION mode or with the Attenuator switched to -80 dBm to -99 dBm in either mode, calibration should be performed in the LOW DISTORTION mode.

All serial numbers. Impedance Selector. 1100, parts list, p. 3-11 change the Board Assy Stock number to 7001-0190. Add capacitor to parts list:

C1	Mica, 12pF, ±5%, 500V	1002-0017	Elmenco	DM15-C-120J

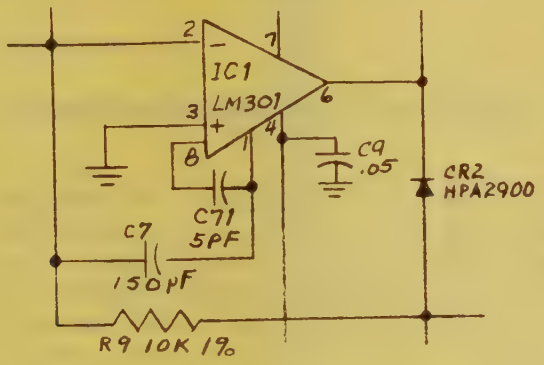
Impedance Selector. 1100, schematic diagram, p. 3-12 add C1 as shown below:



Serial number 471-up. Meter Amplifiers/Audio Amplifiers. 2200, parts list, p. 3-27a add capacitor:

C71	Mica, 5pF, ±.5pF, 500V	1002-0028	Elmenco	DM15-C-050D

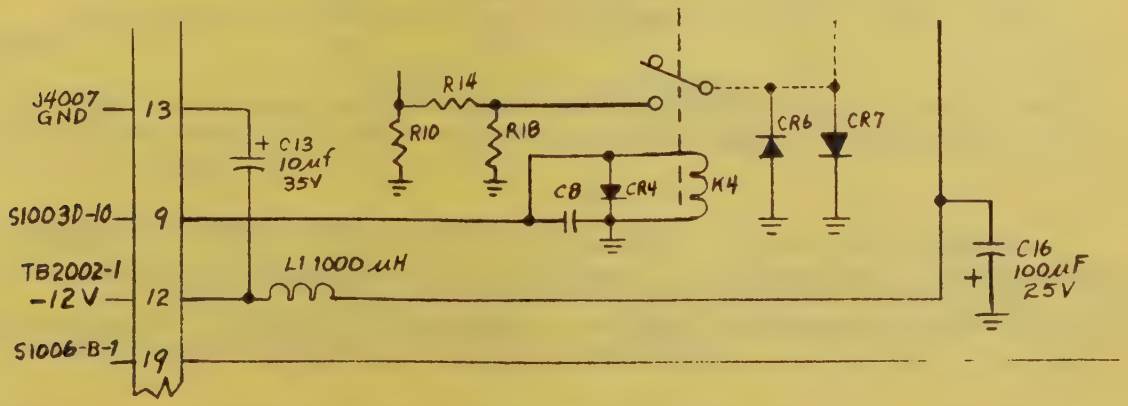
Meter Amplifiers/Audio Amplifiers. 2200, schematic diagram p. 3-31a add C71 as shown below:



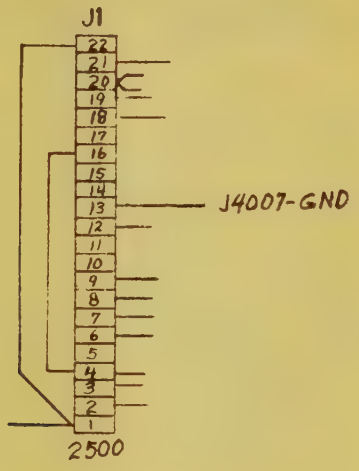
Serial number 381-up. Second IF Amplifier/200 Hz Band Pass Filter. 2500, parts list, p. 3-49 add capacitors and inductor:

C13	Tant, 10μF, +50-20%, 35V	1011-0006	ITT	TAG-10/35-20
C16	Elect, 100μF, ±10%, 25V	1013-0003	Illinois	25T100
L1	RF Choke, 1000μH, ±5%	1585-0020	Delevan	2500-28

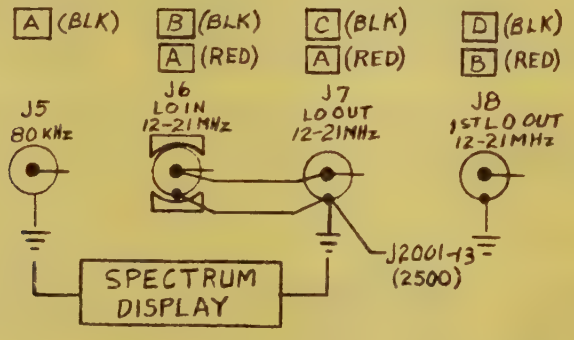
Second IF Amplifier/200 Hz Band Pass Filter. 2500, schematic diagram, p. 3-51, add C13, C16, L1, as shown below:



Serial number 381-up. Main Chassis Interconnections. 2000, p. 3-17, add connection on J1 (2500) from pin 13 to J4007 GND as shown below:



Serial number 381-up. Rear Panel Interconnection Diagram. 4000, p. 3-113. Add ground connection from J7 to J2001-13 (2500) as shown below:



Serial number 401-up. Manual Change Notice, July 1975, p. 4, Balanced Input Amplifier. 3800, parts list, change C19, C23 to new values as follows:

C19, C23	Mica, 47pF, ±5%, 500V	1002-0012	Elmenco	DM15-E-470J

Figure 3-21. Balanced Input Amplifier. 3800, Change Notice p. 4, change value of C19, C23 to 47 pF.

MANUAL CHANGE NOTICE

INSTRUMENT CE-21A MANUAL NO. 5601-0046 DATE PRINTED Oct. 1973

The following changes are necessary to bring your manual up to date. Changes are listed with the instrument serial numbers to which they apply. It is suggested that you enter these changes in your manual immediately.

Serial numbers 261-up.

Page 1-3, delete paragraphs 1.37, 1.38 and substitute the following in their place:

1.37a Two meter amplifiers are required, one for the Normal scale and one for the Expanded scale. Figure 3-5a. The Normal scale amplifier is in the circuit at all times. Amplification for the 80 kHz input is provided by Q1, Q2. IC1 is connected as a unity gain precision amplifier. The meter rectifier, CR1, and the recorder output rectifier, CR2, are each in a feedback loop ground IC1. This provides a very linear current output for the meter, or recorder. C6, C7 provide frequency compensation. R11, C10 and R12, C11 are output filters and R14 divides down the output to a suitable level, which goes to the meter through pin 11.

1.38a The NORMAL/EXP switch, S1004B, directs the output from pin 11 either to the meter, or to the Expanded meter amplifier, IC31, through pin 7. Gain in this amplifier is adjusted by R37 in the feedback loop. Meter zeroing is accomplished by adjusting the DC bias on the negative input of IC31 with R31. Meter protection is provided by the meter limiters CR31-CR33.

A new parts list for the METER AMPLIFIERS/AUDIO AMPLIFIERS, 2200, pages 3-27a, 3-28a, 3-29a and a new schematic diagram, Figure 3-5a, page 3-31a, is attached.

Page 2-9. The Model 211A Bridging Probe is now standard equipment. In the 211A a switch has been added so that the probe input may be set to either Bridging or 75Ω terminated.

Specifications for both the CE-21A and the 211A Tables 1-1 and 1-2 are attached.

Page 2-9, change the title MODEL 211 BRIDGING PROBE to read MODEL 211A BRIDGING PROBE. Under ADJUSTMENT delete steps c. through g., and substitute the following:

c. Set switch on the 211A Probe to TERM.

d. Remove the patch cord connection and connect the CE-26A to the CE-21A with the 211A Bridging Probe. Adjust the CAL control on the 211A for a 0 dBm reading on the CE-21A EXP meter scale.

e. Reconnect the patch cord directly between the instruments, set both to 60 kHz and tune for maximum reading. Adjust CE-21A to 0 dBm with CAL control. Replace the patch cord connection with the 211A Bridging Probe. The reading should be ±0.2 dB.

f. Repeat step e. at 9 MHz. The reading should be 0 dBm ±0.2 dB.

Serial number 261-up.

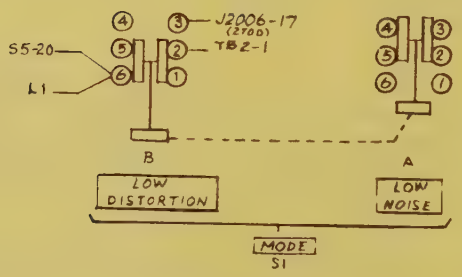
Front Panel, 1000, p. 3-2, 3-3, add inductor as follows:

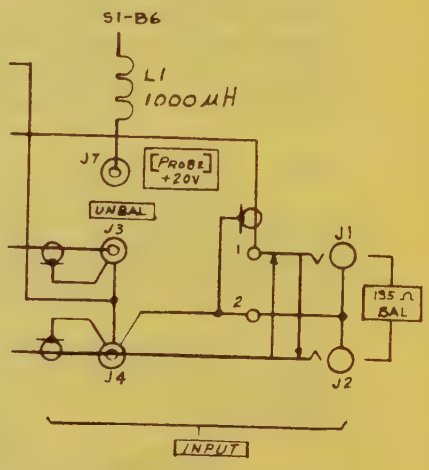
L1	RF Choke, 1000μH, ±5%	1585-0020	Delevan	2500-28

Meter, M1, change stock number to read 1402-0032.

Resistor, R5, change stock number to read: 1203-0065.

Figure 3-1. Front Panel Wiring, sheet 3. 1000, p. 3-9, change connections to S1B, and add L1 to the connection to J7 as shown below:





Serial number 291-up.

Impedance Selector, 1100, parts list, p. 3-11, change the Board Assy., Impedance Selector stock number to 7001-0190. Add capacitor:

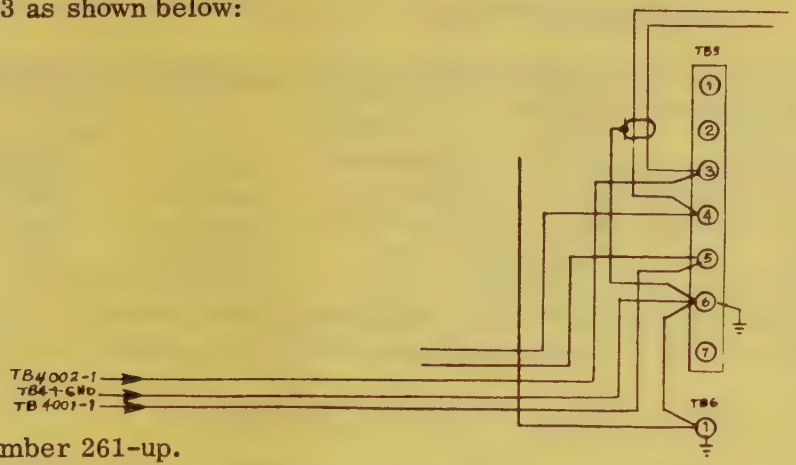
C1	Mica, 12pF, ±5%	1002-0017	Elmenco	DM15-C-120J

Figure 3-2. Impedance Selector. 1100, p. 3-13, add capacitor C1, 12pF between terminals 1 and 8. Change destination of connection to terminal 13 to read S1002-B4. Change destination S1002-B2 to read S1002-B5.

Serial number 410-up.

Main Chassis. 2000, parts list, p. 3-15, delete C1, C2, C3, C4, L1, L5.

Figure 3-3. Main Chassis Interconnections. 2000, p. 3-17. Change the destinations on J2 (2200), pin 14 to S1017C-7 and pin 15 to S1017C-10. Change the connections to TB3 as shown below:



Serial number 261-up.

Meter Amplifiers/Audio Amplifiers. 2200, parts list, p. 3-27 through 3-29 delete. Replace with Meter Amplifiers/Audio Amplifiers, 2200, parts list, p. 3-27a, 3-28a, 3-29a, attached.

Figure 3-5. Meter Amplifiers/Audio Amplifiers. 2200, p. 3-31 delete. Replace with Figure 3-5a. Meter Amplifiers/Audio Amplifiers. 2200, p. 3-31a/3-32, attached.

Serial number 211-up.

Voltage Controlled Oscillator. 2300, parts list p. 3-33, change Board Assy., Voltage Controlled Oscillator (VCO) stock number to 7001-0291. P. 3-38 change Q1-Q9 2N5179 transistors stock number to 1272-0060.

Serial number 291-up.

Sample and Hold/Calibration Amplifier. 2400, parts list, p. 3-41, change capacitor as follows:

C7	Poly, .022μF, ±10%, 100V	1008-0084	Sprague	225P22391WA3

Figure 3-7. Sample and Hold/Calibration Amplifier, sheet 1, 2400, p. 3-45. Change value of C7 to .022.

Serial number 381-up.

Power Supply Rectifiers. 2600, parts list, p. 3-53, change resistors as follows:

R1	Comp, 3.9k, ±5%, 1/4W	1066-3925	AB	CB3925
R3	Comp, 680Ω, ±5%, 1/4W	1066-6815	AB	CB6815
R4	Comp, 820Ω, ±5%, 1/4W	1066-8215	AB	CB8215

Figure 3-9. Power Supply Rectifiers. 2600, p. 3-55. Change the value of resistors, R1 to 3.9k, R3 to 680Ω, R4 to 820Ω.

Serial number 351-up.

Power Supply Regulators. 2800, parts list, p. 3-63, change one diode and three resistors as follows:

CR22	Si, Zener, 3.6V, ±5%	1281-0076	Motorola	1N747A
R23	Comp, 1.6k, ±5%, 1/4W	1066-1625	AB	CB1625
R24	Comp, 10Ω, ±5%, 1/4W	1066-1005	AB	CB1005
R26	Comp, 270Ω, ±5%, 1/4W	1066-2715	AB	CB1005

Figure 3-11. Power Supply Regulators. 2800, p. 3-65. Change the diode CR22 to 1N747A, change resistors, R23 to 1.6k, R24 to 10Ω, R26 to 270Ω.

Serial number 381-up.

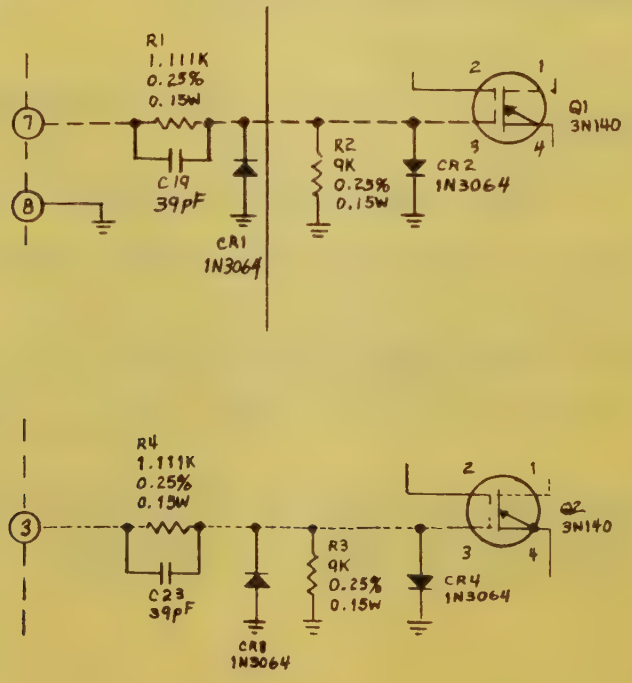
Voltage Controlled Crystal Oscillator. 3700, parts list, p. 3-99, change stock number of Y1 to 2035-0021.

Serial number 261-up.

Balanced Input Amplifier. 3800, parts list, p. 3-103, add two capacitors and four diodes, as follows:

C19, C23	Mica, 39pF, ±5%, 50V	1002-0018	Elmenco	DM15-E-390J
CR1-CR4	Si, Signal, 1N3064	1281-0013	Fairchild	1N3064

Figure 3-21. Balanced Input Amplifier. 3800, p. 3-105, add capacitors and diodes as shown below:

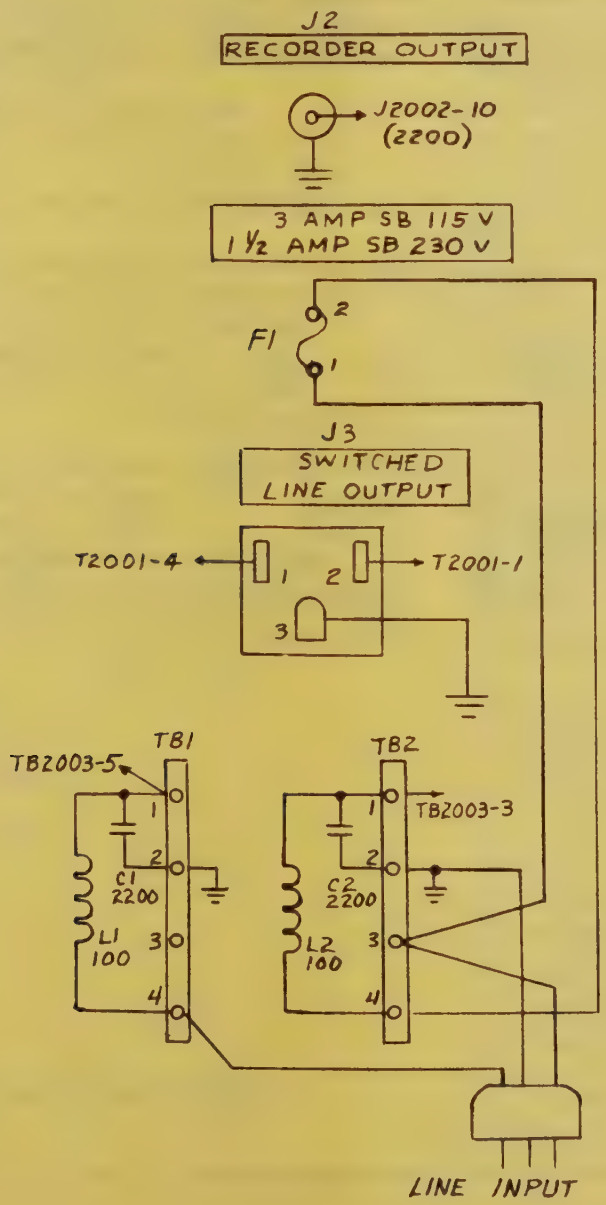


Serial number 410-up.

Rear Panel. 4000, parts list, p. 3-111, add the following:

C1	Cer, 2200pF, ±20%, 3KV	1005-0098	Erie	818Y5
C2	Cer, 2200pF, ±20%, 3KV	1005-0098	Erie	818Y5
L1	RF Choke, 100μH	1585-0040	Miller	5250
L2	RF Choke, 100μH	1585-0040	Miller	5250
TB1	Tiepoint, 4 Pin	1760-0005	Cinch-Jones	54B
TB2	Tiepoint, 4 Pin	1760-0005	Cinch-Jones	54B

Figure 3-23. Rear Panel Interconnection Diagram. 4000, p. 3-113, add terminal strips TB1, TB2; capacitors C1, C2, 2200pF; and RF Chokes L1, L2, 100μH as shown below:



Model 211 Bridging Probe, parts list, p. 3-115, is the same as the 211A with the following changes and additions:

Change:

Bridging Board, P.C. Assy (211A) stock number is 7001-0277.
P.C. Board, stock number is 1780-0201.

Add:

R12	MF, 75Ω, ±1%, 1/8W	1075-0035	Dale	MFF 1/8 T1
Q2	Si, PNP, 2N4121	1272-0023	Fairchild	2N4121
S1	DPST, Min. Slide	1850-0020	Alco Elec.	MSS-22-1

Figure 3-24. Model 211 Bridging Probe, p. 3-117. The Model 211A is the same as the Model 211 in every way except a switch and resistor has been added to the input circuit as shown below. Also the title GAIN ADJ has been changed to CAL.

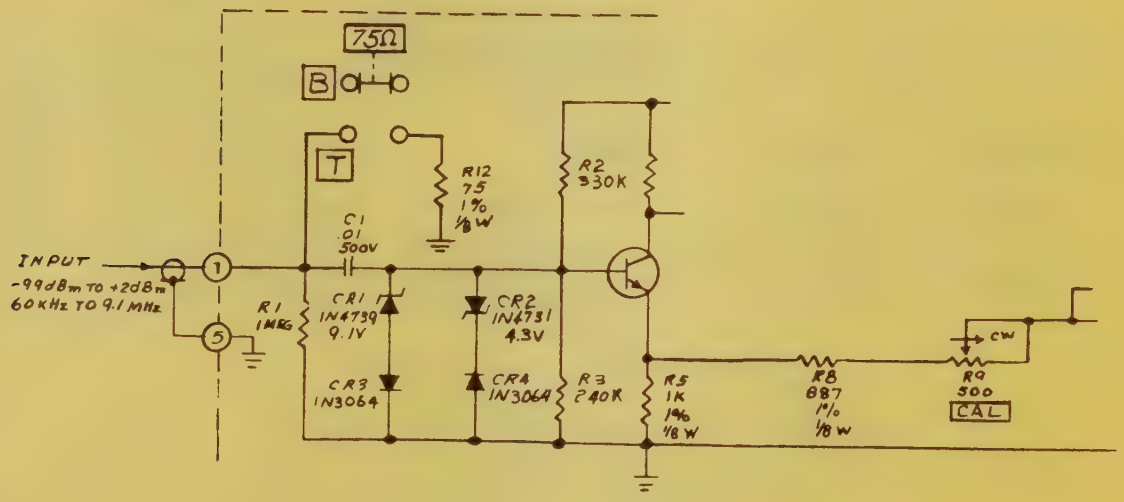


Table 1-1. Specifications, CE-21A

ITEM	CHARACTERISTIC
FREQUENCY	
Range	10 kHz to 9.1 MHz
Digital Resolution	1 kHz
Calibrated Range of continuous inerpolation	1.1 kHz
Stability	≤ 300 Hz from 0°C to +50°C
Aging	≤ 150 Hz per year
LEVEL	
Range, referred to 0 dBm on Meter	
10 kHz to 650 kHz	-99 dBm to +19 dBm
650 kHz to 9.1 MHz	-99 dBm to 0 dBm
Accuracy (With Source Return Loss of ≥30 dB)	
1 MHz - 0 dBm, 75Ω	
25°C ±10°C	±0.1 dB
25°C ±25°C, additional	±0.1 dB
124Ω, 135Ω, (150Ω-M1 option) referred to 75Ω	±0.1 dB
600Ω referred to 75Ω-10 kHz	±0.1 dB
Frequency Response referred to 1 MHz at 0 dBm, 75Ω Unbalanced, or Balanced 124Ω, 135Ω, (150Ω-M1 option)	
60 kHz to 8.5 MHz	±0.2 dB
10 kHz to 60 kHz, 8.5 MHz to 9.1 MHz add'l	±0.1 dB
Frequency Response referred to 10 kHz 0 dBm 600Ω Balanced	
60 kHz to 650 kHz	±0.2 dB
10 kHz to 60 kHz, additional	±0.2 dB
Attenuator referred to 0 dBm at 1 MHz	±0.25dB
Control	1 dB and 10 dB steps
Meter Range	
Normal	-20 dBm to +2 dBm
Expanded	-2 dBm to +2 dBm
Resolution	0.05 dBm
INPUT IMPEDANCE	
Unbalanced	75Ω, 124Ω, 135Ω, 600Ω, (150Ω-M1 option) and 10kΩ shunted by approximately 30pF
Balanced	75Ω, 124Ω, 135Ω, 600Ω (150Ω-M1 option) and 20kΩ shunted by approximately 18pF
INPUT COMMON MODE REJECTION (Balanced Input)	≥ 30 dB

Table 1-1. Specifications, CE-21A

ITEM	CHARACTERISTIC
INPUT DC RATING	Each input to ground, 400 volts (Brdiging Mode only). Do not apply DC in terminating mode.
BANDWIDTH	
Broad	
3 dB	2.3 kHz ±10%
60 dB	≤ 5.0 kHz
Equivalent Noise	1.74 kHz ±10%
Narrow	
3 dB	200 Hz ±10%
60 dB	≤ 800 Hz
Narrow, Optional	
3 dB	45 Hz ±10%
60 dB	≤ 450 Hz
INTERNAL DISTORTION ATTENUATOR (LOW DISTORTION)	
Harmonic	
For 60 dB sensitivity increase, 300 kHz to 9 MHz	≥ 70 dB
For 50 dB sensitivity increase, 60 kHz to 300 kHz	≥ 65 db
Noise Power Ration (Typical)	
Equivalent 600 channel system with stop slot at 2.438 MHz or 70 kHz	
For 40 dB sensitivity increase	≥ 55 dB
Equivalent 1800 channel system with stop band slot at 8.002 MHz or 70 kHz	
For 40 dB sensitivity increase	≥ 45 dB
INTERMEDIATE FREQUENCIES	
I. F. 1	12 MHz
I. F. 2	80 MHz
I. F. REJECTION (I. F. 1 AND/OR I. F. 2)	≥ 70 dB
IMAGE FREQUENCY REJECTION (24 MHz to 33.1 MHz)	≥ 65 dB
OUTPUTS, NOMINAL, AT METER ZERO (RMS and terminated unless otherwise noted)	
PHONES (Phone Jack)	
Output Impedance	8Ω
Audio Speaker Power	1 Watt
DC Recorder (BNC)	
Output Impedance	1kΩ
Output Open Circuit Voltage, DC	-790 mV

Table 1-1. Specifications, CE-21A (con't.)

ITEM	CHARACTERISTIC
Spectrum Display	
80 kHz Out (BNC) A (black)	
Output Impedance	600Ω
Voltage	800μV (600Ω)
L. O. In/Out (BNC) B, C, (black)	
Impedance	50Ω
Voltage	1.5V p-p (50Ω)
Tracking Generator	
1st L. O. Out (BNC) D (black)	
Output Impedance	50Ω
Voltage	50mV (50Ω)
2nd L. O. Out (BNC) E (black)	
Output Impedance	50Ω
Voltage	10 mV (50Ω)
POWER REQUIREMENT	115/230V ±10%, 50-400 Hz 50 Watts
DIMENSIONS	
Height	9-1/4" (23.5 cm)
Width	17-1/4" (43.82 cm)
Depth	18-1/4" (46.36)
WEIGHT	28 pounds (12.7 kg)
ENVIRONMENTAL	
Temperature	
Operating	0°C to 50°C
Storage	-40°C to _75°C
Humidity	95% RH, 40°C
Vibration	10 to 55 Hz, .01" (.03 cm) peak to peak amplitude
Shock	4" (10.16 cm) bench drop
Altitude	
Operative	15,000 ft. (4.57 km)
Non-operative	25,000 ft. (7.62 cm)

Table 1-2. Specifications, 211A

ITEM	CHARACTERISTIC
TELECOMMUNICATIONS EQUIPMENT COMPATABILITY	CE-21A
FREQUENCY RANGE	60 kHz to 9.1 MHz
INPUT SIGNAL LEVEL	-99 dBm to +2 dBm
LEVEL ACCURACY	±0.2 dB
MAXIMUM INPUT SIGNAL LEVEL	
R. F. (Continuous)	+20 dBm
D. C. Voltage on Input	300V
Transient Spikes	600V (peak)
INPUT IMPEDANCE	
Input Resistance	
Bridging	>100 kHz
Terminated	75Ω ±1%
Shunt Input Capacitance	<18 pF
OUTPUT LOAD	CE-21A (Set to 75Ω UNBAL, TERM)
HARMONIC DISTORTION (+0 dBm, 1 MHz Input)	-60 dB Max.
NOISE POWER RATIO (Equivalent 600 Channel System with Stop Band Slot at 2.438 MHz)	60 dB typical
POWER REQUIREMENTS	20V at 30mA, supplied from CE-21A
DIMENSIONS	
Probe Case (Excluding W.E. plug)	1.4" H (3.56 cm), .60"W (1.52 cm) 4.4" L (11.18 cm)
Cable Length (Yellow 75Ω Triax)	10 Ft. (3.05M)
Coax Plug (Excluding Connectors)	1.2" H (3.05 cm), .6" W (1.52 cm), 2.2" L (5.59 cm)
ENVIRONMENTAL	
Temperature, Operating	0° to 55°C
Temperature, Storage	-40°C to +75°C
Humidity	95% RH, 40°C
Vibration	10-55 Hz, .01" (.025 cm) P-P Ampl.
Shock (W.E. Connector Protected)	10 Ft. (3.05M) Bench Drop
Altitude	
Operative	15,000 Ft. (4.57 Km)
Non-Operative	25,000 Ft. (7.62 Km)

METER AMPLIFIERS/AUDIO AMPLIFIERS. 2200

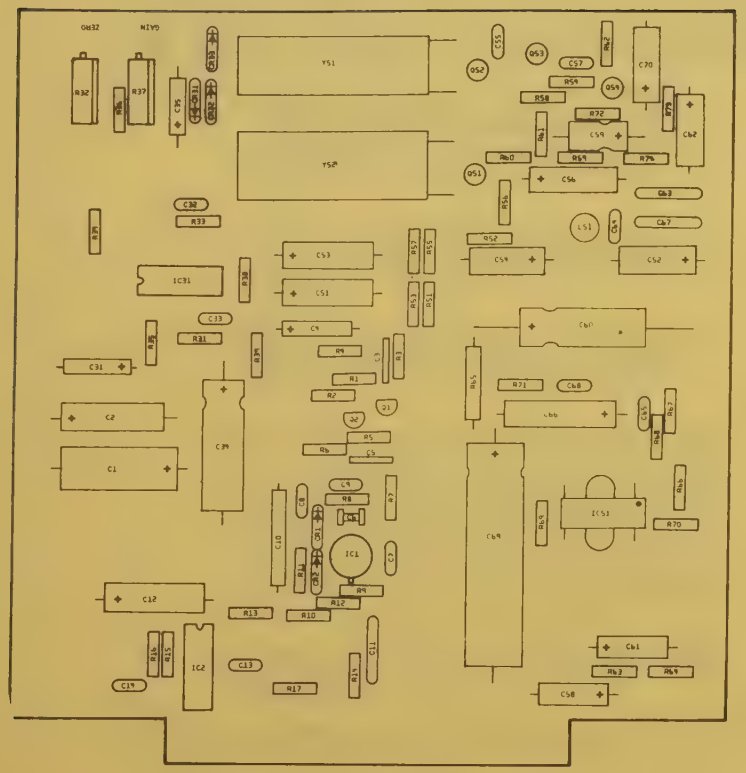
CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2200	Meter Amplifiers/Audio Amplifier	7001-0241	Cushman	
	P.C. Board	1780-0137	Cushman	
	CAPACITORS			
C1	Elect, 100μF, ±10%, 25V	1013-0003	Sprague	30D107G025DD5
C2	Elect, 100μF, +75-10%, 12V	1013-0011	Sprague	30D107G12CC5
C3	Cer, .1μF, ±20%, 25V	1005-0044	Sprague	5C023104X0250B3
C4	Elect, 1.5μF, ±10%, 35V	1013-0001	Sprague	150D155X9035B2
C5	Cer, .1μF, ±20%, 25V	1005-0044	Sprague	5C023104X0250B3
C6	Cer, 3.3pF, ±.25pF, 500V	1005-0011	Erie	301-000-C0J0-339C
C7	Mica, 150pF, ±5%, 500V	1002-0021	Elmenco	DM15-F-151J
C8	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C9	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C10	Poly, .39μF, ±10%, 200V	1008-0037	Electrocube	625B1C394K2
C11	Poly, .0022μF, ±10%, 100V	1008-0020	Sprague	225P22291WA3
C12	Elect, 100μF, +75-10%, 12V	1013-0011	Sprague	30D107G12CC5
C13	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C14	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C15-30	Not Used			
C31	Elect, 1μF, ±10%, 25V	1013-0004	Sprague	30D105G025BA5
C32	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C33	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C34	Elect, 500μF, ±10%, 15V	1013-0014	Mallory	TC1505B
C35	Elect, 1μF, ±10%, 25V	1013-0004	Sprague	30D105G025BA5
C36-50	Not Used			
C51	Elect, 15μF, ±10%, 25V	1013-0005	Sprague	30D156G025BB5
C52	Elect, 1μF, ±10%, 25V	1013-0004	Sprague	30D105G025BA5
C53	Elect, 15μF, ±10%, 25V	1013-0005	Sprague	30D156G025BB5
C54	Elect, 1μF, ±10%, 25V	1013-0004	Sprague	30D105G025BA5
C55	Mica, 200pF, ±5%, 500V	1002-0042	Elmenco	DM15-F-201J
C56	Elect, 15μF, ±10%, 25V	1013-0005	Sprague	30D156G025BB5
C57	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C58	Elect, 1μF, ±10%, 25V	1013-0004	Sprague	30D105G025BA5
C59	Elect, 15μF, +75-10%, 12V	1013-0015	Sprague	30D156G012BA5
C60	Elect, 1000μF, +150-10%, 25V	1014-0006	Corn. Dubl.	WHB10128
C61	Elect, 1μF, ±10%, 25V	1013-0004	Sprague	30D105G025BA5
C62	Elect, 1μF, ±10%, 25V	1013-0004	Sprague	30D105G025BA5
C63	Poly, .027μF, ±10%, 100V	1008-0032	Sprague	225P27391
C64	Mica, 96pF, ±1%, 500V	1002-0049	Elmenco	DM15-F-960F
C65	Mica, 1000pF, ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C66	Elect, 100μF, +75-10%, 12V	1013-0011	Sprague	30D107G012CC5
C67	Poly, .0012μF, ±10%, 100V	1008-0016	Sprague	225P12291WA3
C68	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C69	Elect, 500μF, +100-10%, 25V	1014-0002	Ill. Elna	25T500
C70	Elect, 1μF, ±10%, 25V	1013-0004	Sprague	30D105G025BA5
	CRYSTALS			
Y51	Crystal, 78.0 kHz	2035-0006	Cushman	
V52	Crystal, 82.0 kHz	2035-0007	Cushman	
	DIODES			
CR1	Hot-Carrier, HPA-2900	1283-0003	HPA	5082-2900
CR2	Hot-Carrier, HPA-2900	1283-0003	HPA	5082-2900
CR3-30	Not Used			
CR31	Si, Signal, 1N3064	1281-0013	Teledyne	1N3064
CR32	Si, Signal, 1N3064	1281-0013	Teledyne	1N3064
CR33	Si, Signal, 1N3064	1281-0013	Teledyne	1N3064

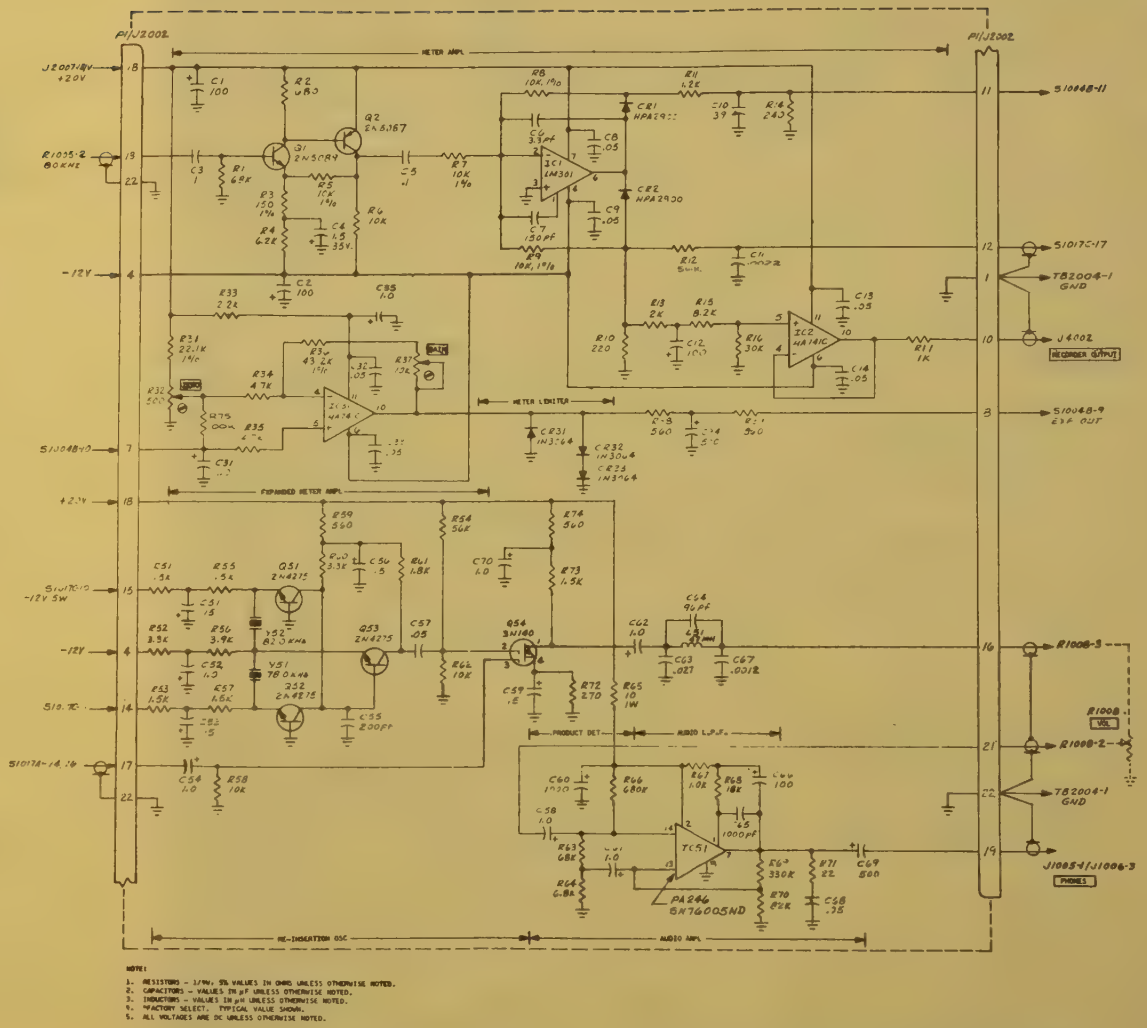
METER AMPLIFIERS/AUDIO AMPLIFIERS. 2200 (cont.)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	INDUCTOR			
L51	RF Choke, 47mH	1585-0044	Cambion	3635-57
	INTEGRATED CIRCUITS			
IC1	Op-Ampl, LM301A	2025-0032	National	LM301A
IC2	Op-Ampl, Hi-Perf, SN72741N	2025-0022	T.I.	SN72741N
IC3-30	Not Used			
IC31	Op-Ampl, Hi-Perf, SN72741N	2025-0022	T.I.	SN72741N
IC-32-50	Not Used			
IC51	Audio Ampl, PA246	2025-0024	G.E.	PA246
	RESISTORS			
R1	Comp, 68k, ±5%, 1/4W	1066-6835	Allen-Bradley	CB6835
R2	Comp, 680Ω, ±5%, 1/4W	1066-6815	Allen-Bradley	CB6815
R3	MF, 150Ω, ±1%, 1/8W	1075-0125	Dale	MFF 1/8 T0
R4	Comp, 6.2k, ±5%, 1/4W	1066-6225	Allen-Bradley	CB6225
R5	MF, 10k, ±1%, 1/8W	1075-0009	Dale	MFF 1/8 T1
R6	Comp, 10k, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R7	MF, 10k, ±1%, 1/8W	1075-0009	Dale	MFF 1/8 T1
R8	MF, 10k, ±1%, 1/8W	1075-0009	Dale	MFF 1/8 T1
R9	MF, 10k, ±1%, 1/8W	1075-0009	Dale	MFF 1/8 T1
R10	Comp, 220Ω, ±5%, 1/4W	1066-2215	Allen-Bradley	CB2215
R11	Comp, 1.2k, ±5%, 1/4W	1066-1225	Allen-Bradley	CB1225
R12	Comp, 56k, ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R13	Comp, 2k, ±5%, 1/4W	1066-2025	Allen-Bradley	CB2025
R14	Comp, 240Ω, ±5%, 1/4W	1066-2415	Allen-Bradley	CB2415
R15	Comp, 8.2k, ±5%, 1/4W	1066-8225	Allen-Bradley	CB8225
R16	Comp, 30k, ±5%, 1/4W	1066-3035	Allen-Bradley	CB3035
R17	Comp, 1k, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R18-30	Not Used			
R31	MF, 22.1k, ±1%, 1/8W	1075-0012	Dale	MFF 1/8 T1
R32	Pot, 500Ω, ±10%, 3/4W	1215-0011	Helitrim	89WR
R33	Comp, 2.2k, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R34	Comp, 4.7k, ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R35	Comp, 4.7k, ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R36	MF, 43.2k, ±1%, 1/8W	1075-0117	Dale	MFF 1/8 T0
R37	Pot, 10k, ±10%, 3/4W	1215-0014	Helitrim	89WR
R38	Comp, 560Ω, ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R39	Comp, 560Ω, ±5%, 1/4W	1066-5615	Allen-Bradley	CB5165
R40-50	Not Used			
R51	Comp, 1.5k, ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R52	Comp, 3.3k, ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R53	Comp, 1.5k, ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R54	Comp, 56k, ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R55	Comp, 1.5k, ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R56	Comp, 3.9k, ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R57	Comp, 1.5k, ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R58	Comp, 10k, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R59	Comp, 560Ω, ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R60	Comp, 3.3k, ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R61	Comp, 1.8k, ±5%, 1/4W	1066-1825	Allen-Bradley	CB1825
R62	Comp, 10k, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R63	Comp, 68k, ±5%, 1/4W	1066-6835	Allen-Bradley	CB6835
R64	Comp, 6.8k, ±5%, 1/4W	1066-6825	Allen-Bradley	CB6825
R65	Comp, 10Ω, ±5%, 1W	1068-1005	Allen-Bradley	GB1005

METER AMPLIFIERS/AUDIO AMPLIFIERS. 2200 (cont.)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R66	Comp, 680k, ±5%, 1/4W	1066-6845	Allen-Bradley	CB6845
R67	Comp, 1k, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R68	Comp, 18k, ±5%, 1/4W	1066-1835	Allen-Bradley	CB1835
R69	Comp, 330k, ±5%, 1/4W	1066-3345	Allen-Bradley	CB3345
R70	Comp, 82k, ±5%, 1/4W	1066-8235	Allen-Bradley	CB8235
R71	Comp, 22Ω, ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R72	Comp, 270Ω, ±5%, 1/4W	1066-2715	Allen-Bradley	CB2715
R73	Comp, 1.5k, ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R74	Comp, 560Ω, ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R75	Comp, 100k, ±5%, 1/4W	1066-1045	Allen-Bradley	CB1045
	TRANSISTORS			
Q1	Si, NPN, 2N5089	1272-0031	Motorola	2N5089
Q2	Si, PNP, 2N5087	1272-0038	Motorola	2N5087
Q3-50	Not Used			
Q51	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q52	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q53	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q54	MOS/FET, Dual Gate, 3N140	1272-0028	RCA	3N140





5601-0046-1

Figure 3-5a. Meter Amplifiers/Audio Amplifiers. 2200

THREE-YEAR WARRANTY

All products manufactured by Cushman Electronics, Inc. are warranteed against defects in material and workmanship for a period of three years from the date of original purchase. Cushman will repair or replace products, which prove to be defective, in accordance with the following policy:

- During the first three months after date of original purchase, no charge for parts, labor and transportation for instruments serviced at an authorized Cushman Service Center. If Cushman cannot repair the instrument, the option of replacing it will be offered.

- During the fourth through the twelfth month after date of original purchase, no charge for parts and labor for instruments serviced at an authorized Cushman Service Center.

- During the second and third year after date of original purchase no charge for parts needed to repair an instrument at an authorized Cushman Service Center.

- During the 3-year warranty period, Cushman will replace instrument printed circuit boards found to be defective. Replacement boards will be shipped directly to the customer after the instrument failure has been identified by an authorized Cushman Service Center. All replacement boards are warranteed against defective material and workmanship for a period of one year after date of shipment. Defective boards must be returned to the appropriate Cushman Service Center within 30 days after receipt of replacement boards.

- During the 3-year instrument warranty period, a free annual calibration will be available at any authorized Cushman Service Center.

This warranty may not apply to instruments or printed circuit boards which, in the opinion of Cushman, have been altered or misused.

CUSHMAN ELECTRONICS, INC.
830 Stewart Drive Sunnyvale, California 94086

TABLE OF CONTENTS

		page
SECTION 1	THEORY OF OPERATION	1-1
	Introduction	1-1
	Circuit Reference Series	1-1
	Functional Description	1-1
	Circuit Description	1-1
	Input and Impedance Selectors. 1000, 1100	1-1
	Hi-Z Attenuators. 3500, 3900	1-1
	15 dB Attenuator. 3600	1-1
	Attenuator Control Logic. 2700	1-1
	Balanced Input Amplifier. 3800	1-2
	Low Pass Filter. 3200	1-2
	First Mixer. 3100	1-2
	First IF Amplifier. 3300	1-2
	Second Mixer. 3400	1-2
	Second IF Amplifier. 2500	1-2
	Second IF Amplifier/2.3 kHz Band Pass Filter. 2900	1-3
	Meter Amplifiers/Audio Amplifiers. 2200	1-3
	Frequency Synthesizer Phase Lock Loop	1-3
	Voltage Controlled Oscillator. 2300	1-3
	Divide-by-N. 2100	1-3
	Master Oscillator, Reference Divider. 2100	1-4
	Sample and Hold. 2400	1-4
	Calibration Amplifier. 2400	1-4
	Calibration Switching	1-5
	Voltage Controlled Crystal Oscillator. 3700	1-5
	Power Supply and Regulator. 2600, 2800	1-5
	Model 211 Bridging Probe	1-5
SECTION 2	MAINTENANCE	2-1
	General	2-1
	Performance Check	2-1
	Test Equipment Required	2-1
	Measurement Accuracy	2-1
	Frequency Response	2-1
	Frequency Accuracy	2-1
	Attenuator Accuracy	2-2
	Harmonic Distortion	2-2
	Adjustment and Calibration	2-2
	Test Equipment Required	2-2
	Control Settings	2-2
	Power Supply	2-2
	Voltage Controlled Oscillator	2-2
	Preliminary Gain Set	2-4
	First Mixer Balance	2-4
	100 Hz Dial	2-4
	Preliminary Master Oscillator Adjust	2-4
	First IF	2-4
	Bandwidth Selector	2-5
	Meter Amplifier	2-5
	Attenuators	2-5
	Harmonic Distortion	2-6
	Frequency Response	2-6
	Common Mode Rejection	2-6
	Image and IF Rejection	2-6
	CAL Level	2-7
	Master Oscillator Adjust	2-7
	Troubleshooting	2-7
	Fuses	2-7
	Operational Calibration	2-8
	Preparation for Reshipment	2-8
	Service of Repair	2-9
	Model 211 Bridging Probe Adjustment	2-9

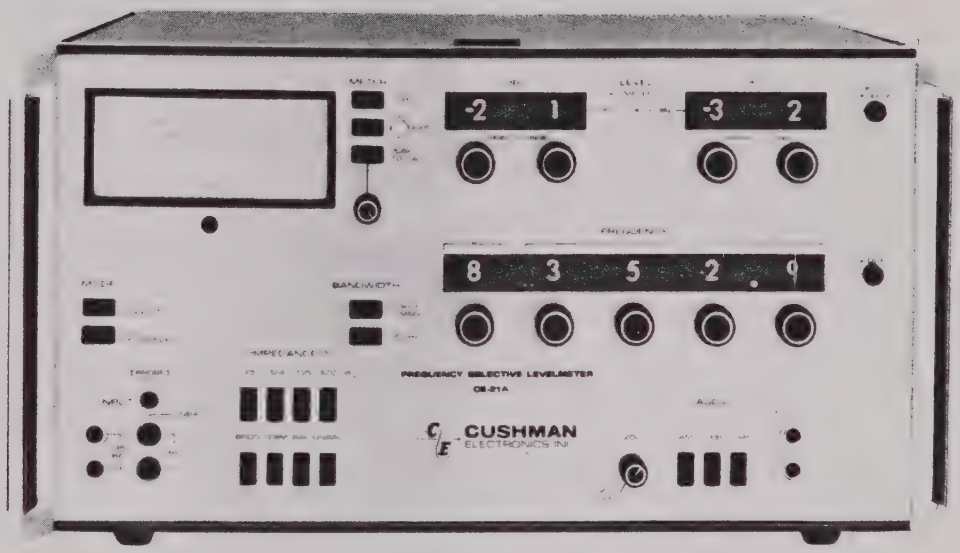
		page
SECTION 3	PARTS LISTS AND SCHEMATIC DIAGRAMS	3-1
	Introduction	3-1

TABLES

Table No.		
2-1	Trouble shooting Chart	2-8
3-1	Printed Circuit Board, Circuit Reference Series Cross Reference	3-1

ILLUSTRATIONS

Figure No.		
1-1	CE-21A Frequency Selective Levelmeter and Model 211 Bridging Probe	viii
1-2	CE-21A Overall Block Diagram	1-7
2-1	Adjustment and Board Locations, Bottom View	2-3
3-1	Front Panel Wiring, sheet 1. 1000	3-5
3-1	Front Panel Wiring, sheet 2. 1000	3-7
3-1	Front Panel Wiring, sheet 3. 1000	3-9
3-2	Impedance Selector. 1100	3-12
3-3	Main Chassis, Interconnections. 2000	3-17
3-4	Master Oscillator/Divide-by-N/Reference Divider, sheet 1. 2100	3-23
3-4	Master Oscillator/Divide-by-N/Reference Divider, sheet 2. 2100	3-25
3-5	Meter Amplifiers/Audio Amplifiers. 2200	3-31
3-6	Voltage Controlled Oscillator. 2300	3-39
3-7	Sample and Hold/Calibration Amplifier, sheet 1. 2400	3-45
3-7	Sample and Hold/Calibration Amplifier, sheet 2. 2400	3-47
3-8	Second IF Amplifier/200 Hz Band Pass Filter. 2500	3-51
3-9	Power Supply Rectfiers. 2600	3-55
3-10	Attenuator Control Logic. 2700	3-61
3-11	Power Supply Regulators. 2800	3-65
3-12	Second IF Amplifier/2.3 kHz Band Pass Filter. 2900	3-69
3-13	Interconnection Diagram, RF Casting. 3000	3-73
3-14	First Mixer. 3100	3-77
3-15	Low Pass Filter. 3200	3-81
3-16	First IF Amplifier. 3300	3-85
3-17	Second Mixer. 3400	3-89
3-18	Hi-Z Attenuator No. 2. 3500	3-93
3-19	15 dB Attenuator. 3600	3-97
3-20	Voltage Controlled Crystal Oscillator. 3700	3-101
3-21	Balanced Input Amplifier. 3800	3-105
3-22	Hi-Z Attenuator No. 1. 3900	3-109
3-23	Rear Panel Interconnection Diagram. 4000	3-113
3-24	Model 211 Bridging Probe	3-117



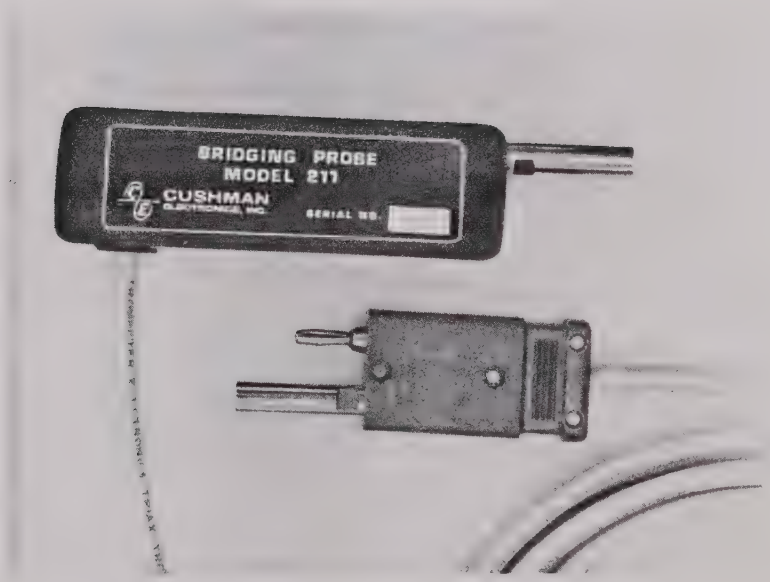


Figure 1-1. CE-21A Frequency Selective Levelmeter and Model 211 Bridging Probe

SECTION 1
THEORY OF OPERATION

INTRODUCTION

1.01 In this section the Circuit Reference Series for circuit and component identification is explained, the overall functioning of the instrument is described and a description of the individual circuit boards is given.

1.02 CIRCUIT REFERENCE SERIES

1.03 The circuits of the instrument are referred to by the series 1000-1100 and 2000-4000. 1000 is the Front Panel, 1100 is the Impedance Selector attached to the front panel, 2000 is the Main Chassis, 2100-2900 are the plug-in circuit boards, 3000 is the RF Housing, 3100-3900 are the circuit boards in the RF Housing and 4000 is the Rear Panel.

1.04 In each circuit the components are individually numbered. The complete identification for a component includes the circuit number. Thus the first resistor on the VCO board will be R2301, the third transistor will be Q2303, etc.

1.05 When the individual circuits are described in the Circuit Description section the component reference will be abbreviated. Only the circuit component number will be used, except when referring to a component in another circuit. In this case the full Circuit Reference Series number will be used.

1.06 Table 3-1 is a cross reference list of the P. C. board numbers and the Circuit Reference Series. The P. C. board number is etched on each board. Each board may thus be identified. These numbers and also the assembly number will also be found in the Parts Lists.

FUNCTIONAL DESCRIPTION

1.07 The CE-21A functions as a double conversion superheterodyne receiver with calibrated input attenuators and a calibrated output meter. The first local oscillator (LO) is a frequency synthesizer that is phase locked to a 2 MHz crystal master oscillator, and which is variable in steps of 1 kHz over the full range of the instrument. This provides crystal controlled accuracy for all synthesized frequencies. The second LO is a voltage controlled crystal oscillator variable over a range of 1.1 kHz to provide continuous frequency control between the smallest synthesizer steps. IF bandpass filters provide selectivity of either 2.3 kHz or 200 Hz. AM is recovered with an audio detector and SSB with upper or lower carrier reinsertion oscillators and a product detector. An audio amplifier provides adequate level for the built-in speaker or for output at the phone jacks. Refer to Figure 1-2 Overall Block Diagram.

CIRCUIT DESCRIPTION

1.08 INPUT AND IMPEDANCE SELECTORS, 1000,1100

1.09 The INPUT and IMPEDANCE selectors are inside a shielded enclosure mounted on the front panel. Figures 3-1 and 3-2. In the BRDG mode the input impedance is that of the Hi-Z attenuators, which is 10kΩ in the UNBAL mode and 20kΩ in the BAL mode. In the 135Ω mode the tip sleeve jacks J1001, J1002, are switched in. This input is used for 135Ω exclusively. When 75Ω, 124Ω or 600Ω is selected the input is through the coaxial jacks J1003, J1004. In each case the proper terminating resistor is switched across the input.

1.10 Hi-Z ATTENUATORS. 3500,3900

1.11 The two attenuators are identical, one being in each input. Figures 3-18 and 3-22. They consist of one 10 dB, one 20 dB and two 40 dB attenuator circuits. Each circuit is the same except for component values. The attenuators are in the circuit when the relays are energized. The relays are controlled by the Attenuator Control Logic, 2700, Figure 3-10, which in turn is controlled by the position of the tens digits of the LEVEL switches dB1 and dB2. In the UNBAL mode, signal is applied to Attenuator No. 1 only, No. 2 being used with No. 1 only in the BAL mode.

1.12 15 dB ATTENUATOR. 3600

1.13 This attenuator provides the one dB steps between the 10 dB steps of the Hi-Z attenuators, Figure 3-19. It is made up of a 1 dB, a 2 dB, a 4 dB and an 8 dB attenuator. The attenuator circuits are switched in as necessary by the Attenuator Control Logic, 2700, Figure 3-10. A maximum of 9 dB is used out of the possible 15 dB. Only one attenuator is necessary at this point in the circuit because the Balanced Input Amplifier, 3800, Figure 3-21, has combined the input signals to a single channel.

1.14 ATTENUATOR CONTROL LOGIC. 2700

1.15 This circuit controls the operation of the Hi-Z attenuators, the 15 dB attenuator, the 20 dB attenuator in the second IF and the panel light indicating -99 dB EXCEEDED, Figure 3-10. This control originates with the front panel switches

dB1, dB2, LOW NOISE/LOW DISTORTION and the PUSH TO CAL switch.

1.16 The logic is performed in the circuits of IC1-10 and the inverters Q1,Q2,Q22. Q3-6 and Q8-12 are the drivers for the attenuator relay switches Q13-21. Q7 drives the -99 dB EXCEEDED panel lamp directly when the inputs of gate CR15, CR16 are positive. CR17, CR18 set the emitter voltage of the switch drivers to ensure that the drivers will turn off.

1.17 When the PUSH TO CAL switch is depressed the logic sets the attenuators for 0 dBm regardless of where the dB1 and dB2 attenuator switches are set automatically setting the calibration level.

1.18 When the LOW DISTORTION mode switch is depressed, the 20 dB attenuator in the second IF is switched out and 20 dB additional attenuation is switched into the Hi-Z attenuators. This is the case only when the total shown by dB1 and dB2 is 79 dB or less. For total dial readings greater than 79 dB the 20 dB attenuator in the second IF is always out of the circuit, regardless of the setting of the LOW NOISE/LOW DISTORTION switch.

1.19 When the total indication on the dB1, dB2 dials is greater than 99 dB, the -99 dB EXCEEDED light comes on to indicate that the minimum level of the instrument has been reached. Although the dB1, dB2 dials may be set to indicate a lower level, such a reading would be meaningless. There is an additional 20 dB available on the meter scale so that the minimum calibrated level is -119 dBm.

1.20 BALANCED INPUT AMPLIFIER. 3800

1.21 This circuit combines the output of both Hi-Z Attenuators into a single output to the 15 dB attenuator. The circuit is made up of two identical channel amplifiers, Q1,Q3 and Q2,Q4 with a combining stage, Q5,Q6. Figure 3-21. The signals in each channel, 180° out of phase, are connected to transistors of opposite polarity in the combiner. In this way the signals add to produce one output signal. R13 equalizes the gain of the two channels. C6, C7 adjust the frequency response. C24 is adjusted for maximum common mode rejection and R24 for minimum distortion.

1.22 LOW PASS FILTER. 3200

1.23 The purpose of the filter is to exclude those frequencies that may cause a spurious indication on the output meter. Response is essentially flat up to 9.3 MHz but then drops off rapidly. The filter is tuned to give maximum attenuation to 11.9 MHz,12.9 MHz,16.2 MHz and 28.3 MHz, the IF and image frequencies most likely to cause a spurious reading. Figure 3-15. Maximum attenuation is greater than 99 dBm and minimum attenuation is not less than 70 dBm.

1.24 FIRST MIXER. 3100

1.25 The signal from the Low Pass Filter is mixed with the First LO in this circuit to produce the First IF signal. The LO frequency enters through T1 and the input signal through T2 to the balanced diode bridge, CR1-CR4. Figure 3-14. R6 and C3 adjust for maximum L.O. rejection, T3 matches the output to the IF amplifier. The equalizer R1-R3,R7, C1, L1 compensates for high frequency roll-off in the Low Pass Filter while maintaining the impedance at a constant value.

1.26 FIRST IF AMPLIFIER. 3300

1.27 Two amplifying stages Q1 and IC1 with a bandpass filter between them make up this circuit. Figure 3-16. The bandpass filter, centered on 11.9995 MHz and having a bandwidth of approximately 5 kHz reduces the noise power and the spur level into the second mixer, and removes any frequencies that are image frequencies of the second, (80 kHz) I. F. amplifier. The amplifier tuned circuits are peaked by adjusting C9, L6 and L7.

1.28 SECOND MIXER. 3400

1.29 The second mixer is much like the First Mixer except that there are no balance adjustments and there is no equalizer circuit in the signal input. Figure 3-17. The signal is brought in through T1 and the Second LO from the Voltage Controlled Crystal Oscillator comes in through T2. Output, at 80 kHz, passes through L1 to the Second IF Amplifier.

1.30 SECOND IF AMPLIFIER. 2500

1.31 This part of the Second IF circuit contains the input amplifier Q1 and buffer amplifier, IC1. Also on this board are four attenuator circuits and the narrow bandpass filter. Figure 3-8. The remainder of the circuit is on board 2900. The 20 dB attenuator is controlled by the LOW NOISE/LOW DISTORTION switch and is switched out in the LOW DISTORTION mode.

1.32 The 124Ω,135Ω and 600Ω attenuators are controlled by the IMPEDANCE selector switches. They are switched in when the corresponding switch is depressed to change the overall I. F. gain so that the meter will read in dBm in each IMPEDANCE position.

1.33 The narrow bandpass filter is centered on 80 kHz and has a bandwidth of 200 Hz. This filter is switched into the circuit when the BANDWIDTH 200 Hz switch is depressed. When the filter is switched out, a pad, R22, R23, R25, is switched in to replace it. The insertion loss of the pad is made the same as the filter with adjustment R23 so that there will be no change in gain

when the filters are switched in or out. Overall gain of the second IF is adjusted with R33. CR6, CR7 limit the maximum signal to IC1 to prevent overload.

1.34 SECOND IF AMPLIFIER/2.3 kHz BAND PASS FILTER. 2900

1.35 This board contains the wide bandwidth filter and the output Second IF Amplifier IC1. Figure 3-12. The wide bandwidth filter is centered on 80 kHz and has a bandwidth of 2.3 kHz. This filter is in the circuit at all times, but the narrower, 200 Hz, bandwidth dominates in setting the I.F. bandwidth when it is in the circuit.

1.36 METER AMPLIFIERS/AUDIO AMPLIFIERS. 2200

1.37 Two meter amplifiers are required, one for the normal scale and one for the expanded scale. Figure 3-5. The normal amplifier is in the circuit at all times. The meter rectifier bridge is in the feedback circuit of operational amplifier, IC1. This connection is used because it provides a very linear current output. The meter bridge CR3, CR4, C8, C9 and meter, are protected by an output limiter CR1, CR2. R6 provides a DC feedback path and R3, R5 along with the bridge impedance determine the amplifier gain. R4, C6 are for high frequency compensation. Output from the bridge through R7 and board pin 11 is connected to the meter through the NORM switch.

1.38 In the EXP mode the meter rectifier output from board pin 11 is connected through the EXP switch to board pin 7 and through amplifier IC31 to board pin 8 which is connected to the meter. The EXP meter amplifier is also an operational amplifier. R41 in the feedback circuit calibrates the gain. Zero offset to center the meter on the scale is adjusted with R33. R35 provides temperature compensation. An output limiter to protect the meter is made up of CR31-CR33.

1.39 Also located on this board are the upper and lower sideband oscillators, the sideband and AM detectors and the audio amplifier. The upper and lower sideband oscillators are turned on by -12V applied to board pins 14 or 15 when the corresponding AUDIO switch is depressed. Input to board pin 17 is from the output of the second IF in the upper or lower sideband mode and Q54 operates as a product detector. The detector output passes through front panel VOL control, R1008, to the audio amplifier, IC51 and then to the PHONES jack or the speaker. In the AM mode, input to board pin 17 is from the output of the meter rectifier through board pin 12. This demodulated signal is applied to Q54 which now operates as an amplifier and then through the VOL control and audio amplifier to the PHONES jack or the speaker. A filtered output from the meter rectifier through board pin 10 goes to the RECORDER connector on the rear panel.

1.40 FREQUENCY SYNTHESIZER PHASE LOCK LOOP

1.41 The phase lock loop circuit of the synthesizer is made up of the Voltage Controlled Oscillator, 2300, Divide-by-N, 2100, and Sample and Hold, 2400, circuits. The 2 MHz Master Oscillator crystal output is divided down to 1 kHz and used to trigger a ramp generator. The ramp is sampled by the output pulse of the Divide-by-N (÷N) circuit to provide a DC output proportional to the phase relation between these signals. The Sample and Hold DC output is fed to the Voltage Controlled Oscillator to adjust the frequency so that the ÷N circuit output is a 1 kHz pulse. When the output is 1 kHz the frequency holds constant in this phase lock condition. The ÷N ratio is set by the front panel FREQUENCY selector switches. In this way each frequency dialed in is phase locked to the Master Oscillator crystal frequency. The synthesizer generates the First LO frequency for the CE-21A First Mixer and also for the First Mixer in the CE-26A when it is being used as a Tracking Signal Generator. These signals are fed out through rear panel connectors.

1.42 VOLTAGE CONTROLLED OSCILLATOR. 2300

1.43 This circuit is made up of nine separate oscillators, each adjustable over a range of 1 MHz, except the 20-21.1 MHz oscillator which has a range of 1.1 MHz. Figure 3-6. Part of the tuning capacitance is furnished by two varicaps in the base circuit of the transistor oscillator. See Figure 3-6 where the 12-13 MHz oscillator is drawn in. The rest of the oscillators are exactly the same except for tuning component values. The oscillators are selected by the MHz dial. The intermediate frequencies over the range of the oscillators are controlled by the voltage applied to the varicaps out of the Sample and Hold circuit. This voltage depends on the setting of the MHz and kHz dials. Output is through the main buffer, IC1 and two output buffers IC2 and Q10. Output from Q10 goes to the CE-21A First Mixer and the output from IC2 is brought to a rear panel connector for use in the CE-26A when it is used as a Tracking Signal Generator.

1.44 DIVIDE-BY-N. 2100

1.45 The ÷N circuits divide the output frequency of the voltage controlled oscillator (VCO) by a ratio set up by the MHz and kHz FREQUENCY selector dials and produce a 1 kHz output when the VCO output is the correct frequency.

1.46 Four programable decade counters, IC1-IC4 and a dual flip-flop, IC7 divide down the VCO frequency. Figure 3-4 sheet 1. IC9 is the coincidence gate, IC5, IC6, IC10 provide control logic, IC8 generates the reset pulse and IC11 is a one shot that stretches the reset pulse to 25μs, making it suitable for use in the Sample and Hold

circuit.

1.47 The required LO frequency is the input frequency plus the First IF frequency and the division ratio for a 1 kHz ÷N output is the LO frequency divided by 1000. For example if the input frequency were 3.456 MHz the LO would be 12.000 MHz +3.456 MHz = 15.456 MHz. The division ratio would then be 15.456 MHz/1000 = 15,456. The counter must be programmed to count to this figure before producing an output. This is done when the dials are set to the desired frequency, in the example above, to 3.456 MHz.

1.48 Since the total capacity of the four counters IC1-IC4 is only 10,000 (a maximum count of 9999) the count must reach the maximum from the preset figure and then start over again from zero and reach maximum a second time before an output is generated. This is taken care of by the logic, the dual flip-flop IC7 and the coincidence gate IC9. For input frequencies of 8.000 MHz and greater the division ratio will be greater than 20,000 therefore the counter must count the remaining count from the preset figure plus two full cycles before generating an output pulse. A switch on the MHz digit for the 8 and 9 position programs the logic and the dual flip-flop to make this possible.

1.49 The preset number for which the counters must be programmed is: the ratio minus the total capacity (as in the example above) 15,456 -10,000 = 5456 remainder, and the maximum count minus the remainder 9999-5456 = 4543, the preset number. This conversion is taken care of automatically by the wiring of the switches.

1.50 MASTER OSCILLATOR, REFERENCE DIVIDER. 2100

1.51 The Oscillator, Q31,Y31 generates a frequency of 2 MHz. CR31, a zener diode, regulates the collector voltage to provide high frequency stability. Small frequency adjustments may be made with C34. Figure 3-4 sheet 2.

1.52 IC35 is a buffer amplifier, biased so that the output is roughly a square wave. The 2 MHz output of IC35 is divided by 2 in IC31 to provide a 1 MHz output at both pins 6 and 8. Output from pin 6 is connected through R39 to tuned circuit L33, C43, C44 which is tuned to 1 MHz. This selects the 1 MHz component of the square wave to provide a sine wave, 1 MHz calibration frequency through board pin W. Output from IC31-8 is connected to the input of the three decade dividers IC32-34 to produce a 1 kHz square wave for the Sample and Hold circuits through board pin X.

1.53 SAMPLE AND HOLD. 2400

1.54 The Sample and Hold circuit provides the control voltage for the varicaps in the Voltage Controlled Oscillator circuit. The circuit output is a voltage proportional to the phase relationship between the 1 kHz output of the Reference Divider and the 1 kHz output of the ÷N circuit. When this relationship is constant the VCO is locked on frequency. If this phase relationship starts to change a correction voltage is generated and the VCO is brought back on frequency.

1.55 The 20% duty cycle pulse from the Reference Divider, through board pin 8, turns on Q2 to discharge C5 for the duration of the pulse. When Q2 is turned off C5 charges through constant current source, Q1, until the next pulse from the Reference Divider. This develops an 80% duty cycle ramp. IC1 is a unity gain operational amplifier that connects the ramp voltage to FET switch, Q3, which is normally off. The very high input impedance of IC1 prevents the charge on C5 from leaking off.

1.56 The output pulse from the ÷N circuit is connected through board pin 10 to IC5-11 and to Q5. Q4,Q5 amplify this pulse which turns on Q3 for the pulse duration, 25μs. This sample of the ramp level is stored on C7 and is prevented from leaking off by the high input impedance of amplifier, IC2. The slope of the ramp makes this pulse unsuitable to control the VCO, it would cause a slight frequency jitter, so a second sample is taken at a later time when the level is constant. The output of IC2 is connected to a second sampling FET switch, Q6. IC5-11,14, a one-shot, is triggered by the input pulse from the ÷N circuit. The trailing edge of this pulse through IC4-8 triggers a second one-shot, IC5-6,3, providing a pulse delayed by the width of the first one-shot pulse. The delayed pulse is buffered by IC6-11, 14, amplified by Q7,Q8 to turn on the sampling gate Q6. The sampled output of Q6 is stored on C9 and is prevented from leaking off by the high impedance of amplifier, IC3. This level, buffered by IC3, is then connected through board pin 14 to the varicaps in the VCO to control the frequency.

1.57 The UNLOCKED light control is also on this circuit board. The outputs from both the Reference Divider and the ÷N circuit are connected to the input of the NAND gate IC4-1,2. If the circuit is out of lock the Reference Divider and ÷N pulse will not be the same frequency and so will rapidly drift through each other. At coincidence IC4-3 will go low and through inverter IC4-6 will trigger the one-shot IC6-6,3. This output will turn on switch, Q9, to cause the UNLOCKED lamp to light. IC4-3 and the one-shot will continue to be triggered until the circuit is again in phase lock. At which time the UNLOCKED light will go out.

1.58 CALIBRATION AMPLIFIER. 2400

1.59 The calibration amplifier IC41 amplifies the 1 MHz output from the Reference Divider. Figure 3-7 sheet 2. The amplifier is biased off by -12V applied to the input through board pin 19 until the CAL switch is depressed. The sine wave output of IC41 is cleaned up with tuned circuit

L44, C52, C53 and connected to board output pin 20.

1.60 Gain is controlled by an adjustable DC voltage applied to one input of the amplifier IC41-1. The output of IC41 is sampled by peak detector, CR43, and is applied as one input to comparator, IC42. A reference voltage, set with R50, is the other input. Comparator output is connected to one input of IC41 to complete the loop to control the gain. CR42 provides temperature compensation for CR43 and zener diode, CR41, regulates the voltage source for R50.

1.61 CALIBRATION SWITCHING.

1.62 In the CAL position all circuits are set up for the Calibrate mode whenever the CAL switch is depressed. The following functions are performed when the CAL switch S1005 is set to the CAL position.

a. Opens the circuit to the panel lights for the FREQUENCY selector switches and the LEVEL attenuator switches.

b. Forces the IMPEDANCE selector switches to 75Ω by removing the control voltage.

c. Disables the FREQUENCY selector and LEVEL switches by opening the common ground circuit. Also removes +20V from the portion of the switch controlling the VCO.

d. Connects the attenuator control to set it for 0 dBm input.

e. Removes negative bias from calibration amplifier to turn it on.

f. Connects the input to the 1 MHz calibrating signal in the UNBAL mode.

g. Turns on the 13-14 MHz VCO oscillator set for 13 MHz. (1 MHz input requires a 13 MHz LO).

The only manual adjustment is setting the front panel CAL control until the meter reads 0 dBm. Calibration should always be performed in the LOW NOISE and the 200 Hz BANDWIDTH mode.

1.63 VOLTAGE CONTROLLED CRYSTAL OSCILLATOR. 3700

1.64 This oscillator generates the second LO frequency which is mixed with the First IF signal to produce the second IF. Q1, Y1 and the varicap, CR1, are the main components of the oscillator. Figure 3-20. The frequency may be varied from 11.9188 MHz to 11.9200 MHz by adjusting the voltage on CR1. R1009, the front panel 100 Hz control, adjusts this voltage. Both ends of R1009 are connected to adjustable voltage dividers, R2602 and R2605, across the +20V supply. These adjustments are used to calibrate R1009 at 0 and 900 Hz. The oscillator output goes to the tuned amplifiers Q2, Q3 which isolate the outputs from each other. Output through Q3 goes to the second mixer. Output through Q2 to the rear panel connector provides the signal for the tracking Signal Generator or Spectrum Display instruments.

1.65 POWER SUPPLY AND REGULATOR. 2600, 2800

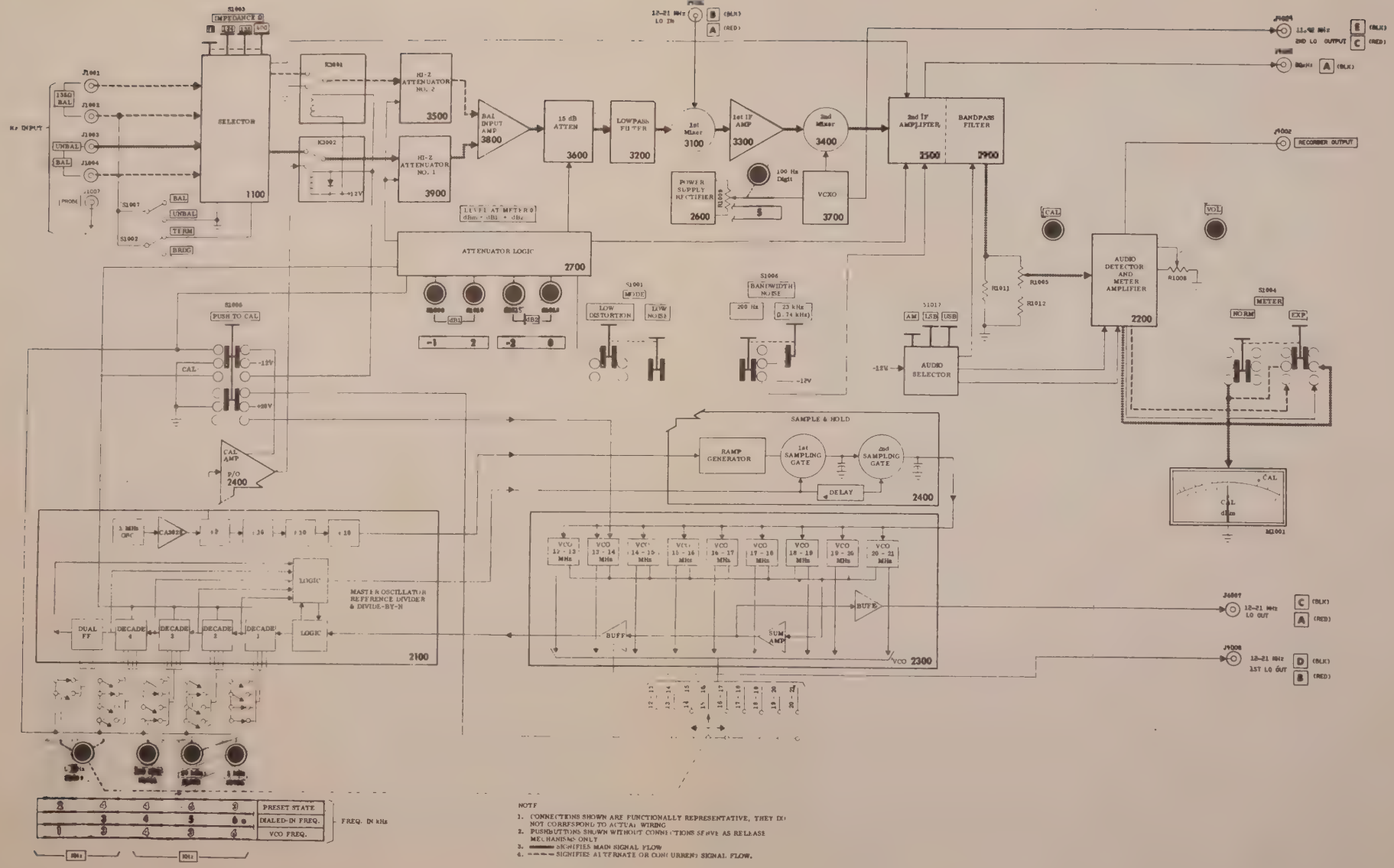
1.66 The outputs of three bridge rectifiers, which are supplied by three secondaries of power transformer T2001, Figure 3-3, are connected to the three regulators to provide +20V, ±5V and -12V to the instrument. Figure 3-9.

1.67 Transformer T2001 also has an additional secondary which furnishes 5.5VAC for the front panel indicator lights. Figure 3-3. An unregulated +20VDC is taken from J2011-7 of the 2600 board to operate the relays in the instrument. Figure 3-11.

1.68 The three regulators are conventional. The series regulator transistors Q2001, Q2002, Q2003 are mounted on the main chassis to provide them with a good heat sink. Figure 3-11. IC1, Q23 and IC41, compare the voltages across zener diodes CR2, CR22, CR42 with the voltages at the adjust points of R7, R25, R45. The output of the comparators is amplified by Q1, Q21, Q41 which drive the series regulator transistors. Q2, Q22, Q42 are overcurrent limiters which limit the output current to a safe level in case of an overload or short circuit of the regulator output. The source for the zener reference diode current for the +5V supply is taken from the +20V bus so that these supplies are tied together.

MODEL 211 BRIDGING PROBE

1.69 The Model 211 is a high impedance probe designed to permit the craftsman to connect the CE-21A Frequency Selective Levelmeter to an 1800 channel transmission system without degrading or interrupting the communications link. The probe consists of an amplifier having unity gain from 60 kHz to 9.1 MHz. The probe has a high input impedance (greater than 100 kΩ and less than 20 pF) and an output impedance of 75Ω to match the input of the CE-21A. Q1, Q2 are the amplifiers and Q3 is an emitter follower output stage. A large amount of negative feedback around the amplifier, through R8, R9, C5, C6 provides for the broad frequency response. Emitter follower, Q3, provides the low output impedance. Gain is adjusted with R9. Input spikes, both positive and negative, are clipped by CR1-CR4.



NOTE

1. CONNECTIONS SHOWN ARE FUNCTIONALLY REPRESENTATIVE, THEY DO NOT CORRESPOND TO ACTUAL WIRING
2. PUSHBUTTONS SHOWN WITHOUT CONNECTIONS SERVE AS RELEASE MECHANISMS ONLY
3. ——— SIGNIFIES MAIN SIGNAL FLOW
4. - - - - SIGNIFIES ALTERNATE OR CONCURRENT SIGNAL FLOW.

5601-0046

Figure 1-2. CE-21A Overall Block Diagram

SECTION 2
MAINTENANCE

GENERAL

2.01 This section of the manual contains the information necessary to check the performance and to adjust and calibrate the CE-21A Frequency Selective Levelmeter.

2.02 The Performance Checks may be used to verify proper operation or as an incoming inspection check. Adjustment and calibration procedures should be carried out only if out of tolerance operation is observed.

2.03 If the Adjustment procedures fail to correct the difficulty, and the cause of the trouble is not readily apparent or cannot conveniently be repaired, it is recommended that the faulty circuit board or the whole instrument be returned to the factory or to a service center for repair. Always contact the Cushman Electronics Customer Service Depart ment before returning equipment or shipping it to a Service Center. See paragraph 2.62.

2.04 The CE-21A should be turned on and warmed up for a few minutes before beginning the Performance Checks or the Adjustment and Calibration procedures.

PERFORMANCE CHECK

2.05 TEST EQUIPMENT REQUIRED

Signal Generator	Cushman CE-26A or equivalent
Electronic Counter	Dana 8100 or equivalent
1 MHz Low Pass Filter	Cirqtel FLT21B-1-5/ 75-3A/3B (30 dB min. attenuation at 2 MHz or equivalent)
60 dB Variable RF Attenuator	Daven 10240C-75-60-7 BNC or equivalent

2.06 Set the CE-21A front panel controls as listed below. Changes will be indicated for procedures as necessary.

METER	EXP
MODE	LOW NOISE
IMPEDANCE	75 OHMS
INPUT	TERM, UNBAL
LEVEL	-0.0 dBm
BANDWIDTH	200 Hz
FREQUENCY	1.0000 MHz
AUDIO	AM
VOL	Just out of PWR OFF

2.07 Set the CE-26A controls as follows:

OUTPUT switch	ON
LEVEL	0.0 dBm
FINE	Set METER to 0 dB
FREQUENCY	1.0000 MHz
TUNING	INT
OUTPUT IMPEDANCE	75Ω UNBAL

2.08 MEASUREMENT ACCURACY

2.09 Connect the 75Ω UNBAL output of the CE-26A to the 75Ω UNBAL input of the CE-21A.

a. Depress the PUSH TO CAL button on the CE-21A and adjust the 100 Hz dial for a maximum meter reading.

b. Adjust the CAL control on the CE-21A for a 0.0 dB reading on the meter.

c. Depress the PUSH TO CAL switch to release it. Adjust 100 Hz dial (on both CE-21A and CE-26A) for a maximum meter reading. The meter should read 0.0 dB ± 0.1 dB on the lower scale.

d. Depress the METER NORM switch. The meter should read 0.0 dB ±0.1 dB on the upper scale.

2.10 FREQUENCY RESPONSE

2.11 Depress the EXP switch on the CE-21A and adjust the CAL control for 0.0 dB on the meter. Check that meter reading is maximum by adjusting the 100 Hz dials on CE-21A and CE-26A.

a. Set the FREQUENCY on both the CE-21A and CE-26A to 100 kHz and adjust for maximum reading with 100 Hz dials. Meter should read 0.0 dB ±0.2 dB.

b. Repeat step a. at 4.1 MHz and 9.1 MHz. At 9.1 MHz the meter should read 0.0 dB ±0.3 dB.

2.12 FREQUENCY ACCURACY

2.13 With the CE-26A still connected to the CE-21A, monitor the output frequency of the CE-26A with a counter.

a. Set the frequency of the CE-21A and the CE-26A to 100 kHz. Set the CE-26A to the correct frequency using the 100 Hz dial.

b. Adjust the 100 Hz dial on the CE-21A for a maximum reading on the meter. (Meter should still be in EXP mode.) The

frequency indication on the CE-21A should be 100 kHz ±350 Hz.

c. Repeat steps a. and b. at 9.1 MHz. Disconnect counter.

2.14 ATTENUATOR ACCURACY

2.15 Set the CE-21A and CE-26A Frequency to 1.000 MHz. Connect RF Variable Attenuator, set to 0.0 dB attenuation, between CE-26A and CE-21A.

a. Adjust both 100 Hz dials for a maximum reading on the CE-21A. Adjust the CAL control for a 0.0 dB reading (meter still in EXP mode) on the CE-21A meter.

b. Set the CE-21A control to +10 dBm and set the CE-26A level to +10 dBm (+9 dB on dial and +1 dB on meter). The CE-21A meter should read 0.0 dB ±0.25 dB.

c. Set the CE-26A to -1 dBm (meter to 0.0 dB and dial to -1 dB). Set the CE-21A dB1 to -0 dBm and dB2 to -1 dBm. CE-21A meter should read 0.0 dBm ±0.25 dB.

d. Repeat step c. setting CE-26A and CE-21A dB2 dials to each 1 dB step between -1 and -9 dBm. CE-21A meter should read 0.0 dBm ±0.25 dB at each step.

e. Set CE-21A dB1 to -0 dBm and dB2 to -10 dBm. Set CE-26A to -10 dBm. The CE-21A meter should read 0.0 dBm ±0.25 dBm.

f. Repeat step e. adjusting CE-21 dB2 and CE-26A Level to each 10 dB step between -10 and -90 dBm. For the three 10 dB steps below -60 dBm set the CE-26A to -60 dBm and set the Variable RF Attenuator to 10, 20 and 30 dB as necessary. CE-21A meter should read 0.0 dB ±0.25 dB at each step.

2.16 HARMONIC DISTORTION

2.17 Disconnect the Variable RF attenuator and connect the 1 MHz Low Pass Filter in its place between the CE-26A and the CE-21A.

a. Set the CE-26A Level to 0 dBm and the Frequency to 1.000 MHz.

b. Set the Frequency of the CE-21A only to 2.000 MHz and set dB1 to -0 dBm and set dB2 to -60 dBm.

c. Adjust the 100 Hz dial for maximum meter indication. Meter should read less than -10 dB (-70 dBm).

ADJUSTMENT AND CALIBRATION

2.18 TEST EQUIPMENT REQUIRED

Digital Multimeter	Dana 4300 or equiv.
Electronic Counter	Dana 8100 or equiv. (Must have input sensitivity or 10mV or better)
RF Voltmeter	Boonton 91D or equiv.
AC Voltmeter	HP400FL or equiv.
Sig. Generator	Cushman CE-26A or equivalent
Sig. Generator Feedthru 75Ω Termination	HP606A or equiv. Texscan FP-75 BNC or equivalent
60 dB Variable RF Attenuator	Daven 10240C-75-60-7 BNC or equivalent
1 MHz Low Pass Filter	(30 dB Rejection at 2 MHz) Cirqtel FLT 21B-1-5/75-3A/3B or equivalent
50/75Ω Matching Pad	Texscan ZM-57 or equivalent

2.19 CONTROL SETTINGS

METER	NORM
PUSH TO CAL	OUT (Normal Operation)
LEVEL dB1	-0 dB
dB2	-0 dB
FREQUENCY	1.0000 MHz
MODE	LOW NOISE
BANDWIDTH	2.3 kHz
IMPEDANCE	TERM, 75Ω, UNBAL
AUDIO	AM
VOL	Just out of PWR OFF

2.20 Turn on the CE-21A and warm up for a few minutes before beginning adjustment procedures. CAUTION NOTE: Always turn off AC power before removing or installing a circuit board. Remove the top and bottom covers.

2.21 POWER SUPPLY

2.22 Measure power supply voltages at J2007 (2800) on top of main chassis, +20V at pin V, 18, +5V at pin R, 14, -12V at pin N, 12. Voltages must be ±0.5V. If adjustment is necessary always adjust +20V first. R2807 adjusts +20V, R2825 adjusts +5V, R2845 adjusts -12V. See Figure 2-1.

2.23 VOLTAGE CONTROLLED OSCILLATOR

2.24 Elevate the 2400 board (Sample and Hold) on extender. Set DMM for DC and connect to TP7 on the 2400 board.

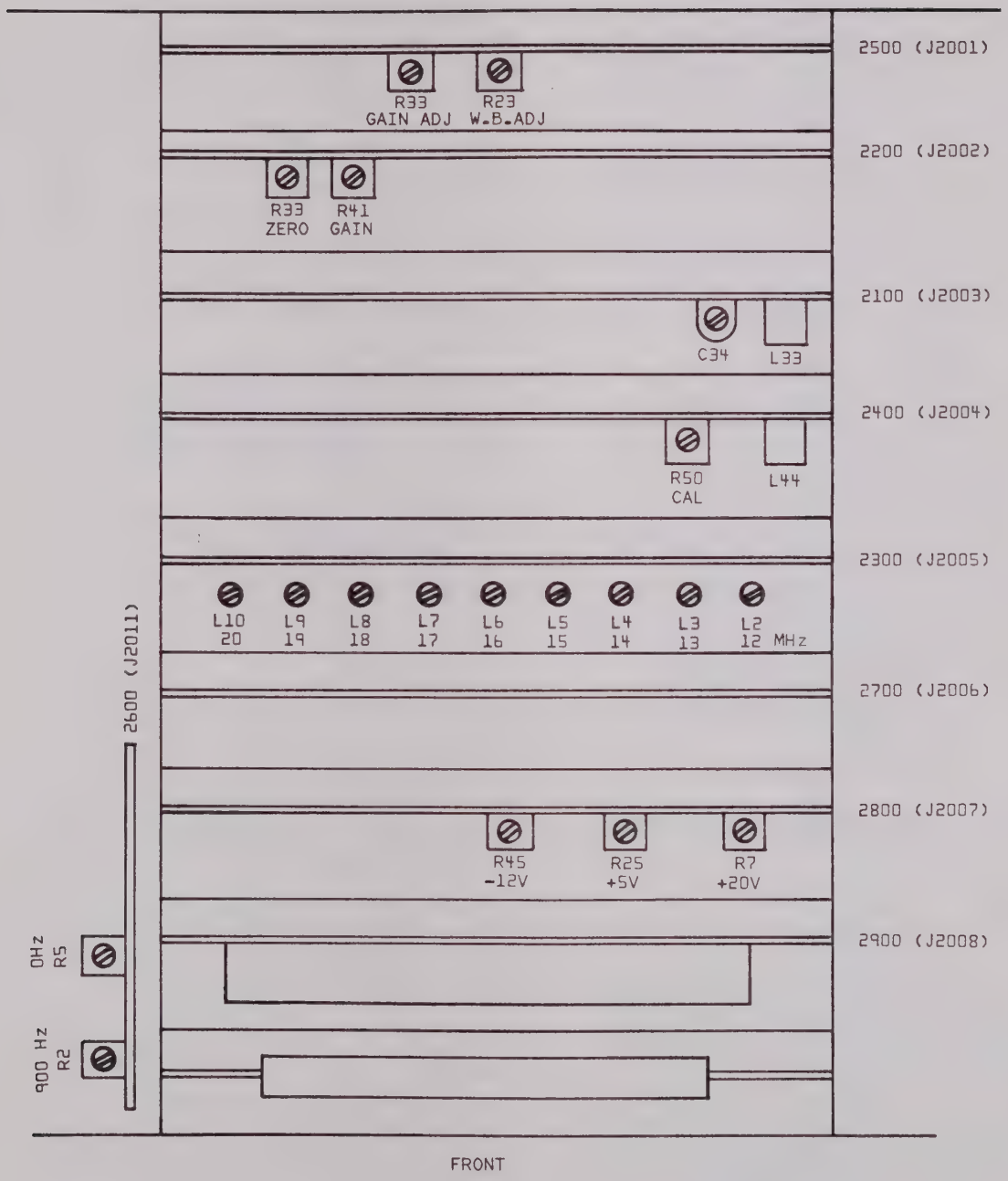


Figure 2-1. Adjustment and Board Locations, Bottom View.

a. Dial in 0.999 MHz on the FREQUENCY selector. Meter should read 13.0V ±0.1V. If necessary adjust L2302 (12 MHz coil) for this reading. See Figure 2-1.

b. Dial in 1.999 MHz. Adjust L2303 (13 MHz coil) for a 13.0V ±0.1V reading.

c. Follow the same procedure for 2.999 MHz, L2304; 3.999 MHz, L2305; 4.999 MHz, L2306; 5.999 MHz, L2307; 6.999 MHz, L2308; 7.999 MHz, L2309; 9.100 MHz L2310. DMM reading must be 13.0V ±0.1V for each setting.

d. Dial in 8.000 MHz. Reading should be 4.5V ±0.5V.

e. Follow same procedure (d.) for 7.000, 6.000, 5.000, 4.000, 3.000, 2.000, 1.000, 0.0000 MHz. Readings should be 4.5V ±0.5V. Replace 2400 board.

2.25 PRELIMINARY GAIN SET

2.26 Set controls as in para. 2.19 except set LEVEL to -70 dBm, FREQUENCY to 0.000 MHz and BANDWIDTH to 200 Hz.

a. Center CAL control.

b. Set CE-26A to -70 dBm (-69 on dial and -1 dB on meter) and connect 75Ω UNBAL output to CE-21A UNBAL input.

c. Set CE-21A 100 Hz dial to 0 and tune for maximum meter reading with 100 Hz dials on both CE-21A and CE-26A.

d. Adjust R2533 for 0 dB ±0.1 dB on the CE-21A meter.

2.27 FIRST MIXER BALANCE

2.28 Set controls as in para. 2.19 except set FREQUENCY to 9.9 kHz.

a. Disconnect any signal from INPUT.

b. Decrease setting of 1 kHz dial until a reading appears on the meter.

c. Very carefully adjust C3103 and R3106 for a minimum reading on the meter. Access holes to these adjustments are on the RF casting toward the front on the inside.

d. Increase the meter reading by adjusting the 1 kHz and 100 Hz dials. Continue to adjust C3103 and R3106 for a minimum reading on the meter until the lowest null is reached. It should be possible to bring the meter below full scale for a 2 kHz FREQUENCY setting.

2.29 100 Hz DIAL

2.30 Set controls as in para. 2.19.

a. Connect counter to J4009 (red C, black E) on rear panel. Use 12 MHz amplifier if necessary.

b. With 100 Hz dial set to "0" adjust R2605 (0 Hz) (see Figure 2-1) until counter reads 11.9200 MHz ±50 Hz.

c. Set 100 Hz dial to "9" and adjust R2602 (900 Hz) until the counter reads 11.9191 MHz ±50 Hz.

d. Repeat steps b. and c. until no further adjustment is required.

e. Check with dial set at 5 and -1, counter should read 11.9195 ±50 Hz and 11.9201 ±50 Hz.

f. Disconnect counter from J4009 (red C, black E) and connect RF voltmeter (using 50 ohm probe) in its place. Output level should be 13mV ±3mV. Adjust L3702 (bottom of RF casting) for a maximum reading.

2.31 PRELIMINARY MASTER OSCILLATOR ADJUST

2.32 Set FREQUENCY to 9.100 MHz

a. Connect counter to J4008 (red B, black D).

b. Adjust C2134 (see Figure 2-1) until counter reads 21.100 MHz ±5 Hz.

c. Set FREQUENCY to 0.000 MHz. Counter should read 12.000 MHz ±5 Hz.

d. Set FREQUENCY to 5.555 MHz. Counter should read 17.555 MHz ±5 Hz.

e. Connect RF Voltmeter to J4008 (red B, black D) in place of counter, use 50 ohm probe. Meter should read 50mV ±15 mV.

f. Connect RF Voltmeter to J4007 (red A, black C) use 50 ohm probe. Meter should read 360mV ±30mV.

2.33 FIRST IF

2.34 Set controls as in para. 2.19 except set LEVEL to -50 dBm.

a. Set CE-26A to 1.000 MHz at -50 dBm and connect 75 ohm UNBAL output to

CE-21A 75 ohm UNBAL input.

b. Connect AC Voltmeter to J4005 (black A) and adjust C3309, L3306, L3307 (top of RF casting) for a maximum reading on the AC Voltmeter.

c. Tune for a maximum reading on the CE-21A meter with the 100 Hz dials.

d. Switch CE-21A to EXP METER scale and adjust L3703 for a maximum meter reading.

2.35 BANDWIDTH SELECTOR

2.36 Set CE-21A controls as in para. 2.19 except set METER to EXP, BANDWIDTH to 200 Hz, FREQUENCY to 999 kHz.

a. Set CE-26A to 0 dBm, 999 kHz, 75 ohm UNBAL and connect to UNBAL input of CE-21A.

b. Tune for maximum meter reading and set to 0 dB with the CAL control.

c. Switch BANDWIDTH to 2.3 kHz and adjust R2523 for a 0 dB meter reading.

d. Switch back to 200 Hz BANDWIDTH. Reset frequency on both instruments to 0999.4 kHz and fine tune CE-21A for a peak reading.

e. Adjust CAL control for a +1 dBm reading on the meter.

f. Slowly adjust frequency of generator for -3 dB points on both sides of maximum. Ripple should be less than 0.2 dB. Bandwidth should be 200 Hz ±20 Hz.

g. Retune generator for a peak reading and then switch to 2.3 kHz BANDWIDTH. Tune generator and observe frequencies at which level is decreased by 0.1 dB. The difference between these two frequencies should not be less than 500 Hz. Must be flat within .1 dB on both sides of peak.

h. Tune generator and observe the frequency at the -3 dB points. Bandwidth should be 2.3 kHz ±230 Hz.

2.37 METER AMPLIFIER

2.38 Set CE-21A controls as in para. 2.19 except set LEVEL to -60 dBm and FREQUENCY to 999 kHz.

a. Set CE-26A to -60 dBm and 999 kHz. Connect 75 ohm UNBAL output to CE-21A 75 ohm UNBAL input.

b. Switch to 200 Hz BANDWIDTH and adjust 100 Hz dial for maximum level.

c. Switch back to 2.3 kHz BANDWIDTH and adjust for a meter reading of 0 dBm with CAL control.

d. Switch to 200 Hz BANDWIDTH and set METER to EXP position. Adjust R2233 (zero) for a 0 dBm reading on the meter.

e. Set CE-26A LEVEL to -62 dBm. Adjust R2241 (GAIN) for -2 dBm meter reading and repeat d. and e. until both conditions are met.

f. Set CE-26A LEVEL to -59 and -58 dBm. Meter should read +1 and +2 dBm. All readings must be within ±0.03 dB.

2.39 ATTENUATORS

2.40 Set the controls as in para. 2.19 except set METER to EXP, LEVEL to -70 dBm and FREQUENCY to 9.100 MHz.

a. Set the CE-26A to -70 dBm, 9.100 MHz and connect 75 ohm UNBAL output to CE-21A 75 ohm UNBAL input.

b. Tune for maximum and adjust CAL for a 0 dB reading on the CE-21A meter. Simultaneously step the attenuators of both instruments in 10 dB steps from -70 dBm to 0 dBm. CE-21A meter should read 0 dB ±0.15 dB at each step. If any reading falls outside this limit adjust Hi-Z Attenuator #1 (3900) on bottom of RF casting according to step c.

c. Attenuator adjustments

CE-21A dBm	Adj Hi-Z #1	Adj Hi-Z #2
-90	No adj	No adj
-80	No adj	No adj
-70	No adj	No adj
-60	C3905	C3505
-50	C3906	C3506
-40	C3903	C3503
-30	C3907	C3507
-20	C3904	C3504
-10	No adj	No adj
0	No adj	No adj
+10	C3901	C3501

The level positions in which no adjustment is made use attenuators that are adjusted in other positions, refer to paragraph 1.11 and Figures 3.18 and 3.22. After making adjustments step b. should be repeated. To check down to -90 dBm insert

10 dB and 20 dB fixed attenuators between CE-26A and CE-21A.

d. Reset both the CE-21A and the CE-26A to 0 dBm and re-zero meter with CAL control. Step both CE-26A and CE-21A down to -9 dBm in 1 dB steps. Meter should read 0 dB ±0.25 dB.

e. Switch CE-21A to BAL. Insert a shorting plug in UNBAL input and connect CE-26A to BAL input. Repeat steps b. through d. and adjust Hi-Z attenuator #2 (3500) according to step c.

f. Repeat the procedures of steps b., d., and e. for 650 kHz and 99 kHz, from -70 to +10 dBm. At 650 kHz make the +10 dBm adjustments of step c. Do not make any adjustments at 99 kHz.

g. Repeat step f. in the LOW DISTORTION mode, but do not make any adjustments.

2.41 HARMONIC DISTORTION

2.42 Set controls as in para. 2.19 except set MODE switch to LOW DISTORTION.

a. Set CE-26A to 1.000 MHz, 0 dBm and connect 75 ohm UNBAL output to CE-21A 75 ohm UNBAL input through a 1 MHz Low Pass Filter (LPF). Adjust generator for a 0 dBm level on the CE-21A.

b. Change FREQUENCY of CE-21A only to 2.000 MHz and set LEVEL to -60 dBm. Adjust R3824 for a reading of less than -70 dBm.

c. Switch CE-21A to BAL, place a shorting plug in the UNBAL input and connect the CE-26A to the BAL input. Level should still read less than -70 dBm. If necessary readjust R3824. Repeat steps b. and c. until reading in both is below -70 dBm.

2.43 FREQUENCY RESPONSE

2.44 Set controls as in para. 2.19 except set INPUT to BRDG, METER to EXP, LEVEL to -70 dBm and FREQUENCY to 999 kHz.

a. Set the CE-26A to -70 dBm at 999 kHz and connect 75 ohm UNBAL output through a 75 ohm termination to the CE-21A 75 ohm UNBAL input.

b. Adjust the CE-21A CAL control for a 0 dBm reading on the meter.

c. Set CE-26A and CE-21A to 9.100 MHz. Adjust C3806 (bottom of RF casting) for a 0 dB reading on the meter.

d. Insert a shorting plug in the UNBAL jack and connect the CE-26A to the BAL jack. Switch to BAL input. Adjust C3807 for a 0 dB meter reading.

2.45 COMMON MODE REJECTION

2.46 Set controls as in para. 2.19 except set LEVEL to -70 dBm and FREQUENCY to 999 kHz.

a. Connect the output of the CE-26A to a 75 ohm feedthru termination. Connect a BNC Tee to the end of the 75 ohm termination. Connect a 12 inch BNC coaxial cable to each end of the BNC Tee. Connect a coaxial plug to the end of each coaxial cable.

CAUTION

Length on both sides from tip of cable to center of Tee must be equal within less than 1/2 inch.

b. Connect one coaxial plug to the UNBAL input of the CE-21A. Adjust CE-26A for a 0 dB reading on the CE-21A meter.

c. Connect the other coaxial plug to the BAL jack and switch input to BAL.

d. Set CE-26A LEVEL to -40 dBm. Adjust R3813 (bottom of RF casting) for a minimum reading. LEVEL should read less than -75 dBm on CE-21A.

e. Decrease attenuators of both instruments in 10 dB steps. Common Mode Rejection must be at least -35 dB at each setting. The Common Mode Rejection is the amount in dB by which the CE-21A reading (dial and meter) is less than the CE-26A reading (dial and meter).

f. Increase frequency of both instruments to 9.100 MHz. Repeat steps b., c. and d. except adjust C3824 for a minimum reading. Repeat step e.

2.47 IMAGE AND IF REJECTION

2.48 Set controls as in para. 2.19 except set LEVEL to -70 dBm.

a. Set HP606A frequency to 12.0 MHz and LEVEL to +5.6 dBm. Connect generator output to CE-21A through a 50/75 ohms matching pad.

b. Fine tune the HP606A for a maximum reading on the CE-21A. Level should be less than -70 dBm.

c. Change the frequency of the HP606A to 25 MHz and fine tune for a maximum reading on the CE-21A. Level should be less than -68 dBm.

d. Change the frequency of the CE-21A to 5 MHz and the HP606A to 29 MHz and fine tune for a maximum reading on the CE-21A. Level should be less than -68 dBm.

e. Change CE-21A to 9.1 MHz and the HP-606A to 33.1 MHz and fine tune for a maximum reading on the CE-21A. Level should be less than -68 dB.

f. If the Image and I.F. Rejection check does not meet the requirements, it is recommended that the Low Pass Filter board, 3200, be returned to the factory for realignment, since the equipment required for this alignment is not ordinarily readily available in the field.

2.49 CAL LEVEL

2.50 Set controls as in para. 2.19 except set METER to EXP and BANDWIDTH to 200 Hz. Depress PUSH TO CAL switch.

a. Elevate 2100 board on extender. Adjust L2133 (see Figure 2-1) for a maximum reading on meter. Replace 2100 board.

b. Elevate 2400 board on extender. Adjust L2444 for a maximum reading on meter. Replace 2400 board.

c. Set CE-26A to 1.000 MHz, 0 dBm, 75 ohms, and connect UNBAL output to CE-21A 75 ohms UNBAL input.

d. Release PUSH TO CAL switch. Peak reading on meter with 100 Hz dials. Set CAL control mark to line on front panel (straight up).

e. Adjust R2533 (GAIN), See Figure 2-1, for 0 dB on the EXP meter scale.

f. Depress PUSH TO CAL switch and tune for a peak reading on meter with the CE-21A 100 Hz dial.

g. Adjust R2450 (CAL) for a 0 dB reading on the EXP meter scale.

h. Switch METER to NORM. Meter should read 0 dB on NORM scale. If it does not, repeat procedure of para. 2.38 Meter Amplifier, then repeat steps c-h.

2.51 MASTER OSCILLATOR ADJUST

2.52 Replace covers on CE-21A and allow to warm up for at least an hour. Repeat step 2.32 for the final Master Oscillator adjustment.

TROUBLESHOOTING

2.53 When trouble is experienced make sure of AC power to instrument, that power fuse is OK, that dial lights are on. If dial lights are not on be sure the PUSH TO CAL switch is in the out position.

a. Make sure that all controls are set in their proper position. Make certain signal is plugged into the proper jack and that input controls are properly set.

b. For further checks refer to the Troubleshooting Chart Table 2-1.

c. If another CE-21A is available a quick way to localize trouble is by board substitution.

d. When trouble is localized the defective board or the complete instrument may be returned to the factory for repair.

Always contact the Cushman Electronics Customer Service Department before returning parts or instruments. See paragraph 2.62.

2.54 FUSES

2.55 The main fuse, 3A SLO-BLO, is mounted on the rear panel and is accessible from the outside of the instrument. Each of the power supplies is individually fused. The fuses are mounted on the power supply board, 2600, which is mounted on the right side of the inner chassis. The fuses are, from front to rear, +5V, -12V, +20V. The +20V and -12V fuses are 1A SLO-BLO and the +5V fuse is 2A SLO-BLO. If one of these fuses should blow, check the power supply circuits to determine the cause before again turning on the AC power. Approximate resistances to ground, with AC power disconnected, at the DC test point, see paragraph 2.22, on the Power Supply Regulators board are: +20V approximately 90 ohms, -12V approximately 20 ohms, +5V approximately 30 ohms. Resistances may vary considerably with type of ohmmeter and polarity of test leads.

Table 2-1. Troubleshooting Chart

Indication	Possible Cause	Check
UNLOCKED light on	Dialed frequency greater than 9.2 MHz	Frequency selector setting
UNLOCKED light on at certain MHz dial settings	Associated MHz oscillator circuit not operating	VCO circuit. Adjust as necessary, paragraph 2.24
UNLOCKED light on at all frequencies	Defective board in synthesizer loop	2100, 2300, 2400 boards. Adjust as necessary
Instrument will not calibrate. Audio and relays OK	+5V power supply defective	Adjust or repair +5V power supply
Will not calibrate. Audio OK, relays do not work	-12V power supply defective	Adjust or repair -12V power supply
Will not calibrate. No audio. Relays do not work	+20V power supply defective	Adjust or repair +20V power supply
Calibrates OK. Will not receive. Audio noisy, or no sideband audio	Input or impedance switches improperly set	Operate switches to make certain they are properly set
No audio in USB, LSB or AM	Meter amplifier/Audio amplifier board defective	Adjust Meter/Audio amplifier board as necessary
Will not calibrate and will not receive	Internal or external jumper not connected between J4006-J4007 (Red A, Black B-Red A, Black C)	Connect jumper either internally or externally

OPERATIONAL CALIBRATION

2.56 Calibration of the CE-21A is semiautomatic. When the PUSH TO CAL switch is depressed the input circuit is switched to 75 ohms, an internally generated calibration signal is provided, the frequency of the 1st LO is preset for 1 MHz and the attenuators are adjusted for a 0 dBm input. The meter is then manually set to zero. This calibrates the instrument for all available input impedances and for all frequencies within the range of the CE-21A.

2.57 Perform the following steps:

a. Depress the PUSH TO CAL switch. All the LEVEL and FREQUENCY readouts are now darkened except the 100 Hz frequency control.

b. Depress the LOW NOISE, the 200 Hz BANDWIDTH, and the METER EXP switches.

c. Rotate the 100 Hz frequency control until a peak reading is obtained on the meter.

d. Zero the meter on the EXP meter scale by adjusting the control below the PUSH TO CAL switch.

e. Depress the METER NORM switch. The reading on the upper meter scale should be 0 dB ±0.1 dB.

f. Depress the 2.3 kHz BANDWIDTH switch. The meter reading should be 0 dB ±0.1 dB.

g. Depress the LOW DISTORTION switch. The average reading should be 0 dB ±0.1 dB.

h. Depress the LOW NOISE switch. Depress the PUSH TO CAL switch to release it. The instrument is now ready for use.

NOTE: Whenever the CE-21A is placed in the LOW DISTORTION mode the meter will show small random fluctuations due to the reduced signal-to-noise ratio in this mode. Accuracy is slightly reduced due to these fluctuations. The instrument should never be calibrated in the LOW DISTORTION mode.

PREPARATION FOR RESHIPMENT

2.58 It is recommended that the shipping box and foam packaging be kept in case it

becomes necessary to return the instrument to the factory or service point for service or repair.

2.59 The following paragraphs contain a general guide for repackaging of the instrument for shipment.

NOTE

If the instrument is to be shipped, attach a tag to the instrument identifying the owner, and indicating the service or repair to be accomplished. Include the model number and full serial number of the instrument. In correspondence, identify the instrument by model number, serial number, and part number.

2.60 If the original container is to be used, proceed as follows:

a. Place the instrument in the original container. (If the original container is not available, one can be purchased from Cushman Electronics.)

b. Ensure that the container is well sealed with strong tape or metal bands.

2.61 If the original container is not used, proceed as follows:

a. Wrap the instrument in plastic or heavy paper before placing in an inner container.

b. Place packing material around all sides of the instrument.

c. Place the instrument and inner container in a heavy carton or wood box, and seal with strong tape or metal bands.

d. Mark the shipping container: "DELICATE ELECTRONIC INSTRUMENT," "FRAGILE."

SERVICE OR REPAIR

2.62 In the event service or repair is required, contact:

Cushman Electronics, Inc.
Customer Service Department
830 Stewart Drive
Sunnyvale, California 94086
Area Code: 408
Telephone: 739-6760

Repair service for Cushman Electronics equipment is available at:

BCS Associates, Inc.
940 North Fern Avenue
Orlando, Florida 32803
Area Code: 305
Telephone: 896-4881

Reshal Associates
219 West University Drive
Arlington Heights, Illinois 60004
Area Code: 312
Telephone: 398-7660

MODEL 211 BRIDGING PROBE

ADJUSTMENT

2.63 Equipment required:

CE-21A Frequency Selective Levelmeter
CE-26A Signal Generator, or equivalent

2.64 Set both instruments to 75Ω, UNBAL, TERM. Set LEVELS to 0 dBm, and set frequency to 1 MHz.

a. Set the CE-21A METER to EXP, BANDWIDTH to 200 Hz, MODE to LOW NOISE.

b. Connect the CE-26A directly to the CE-21A with a suitable patch cord and tune for a maximum reading on the CE-21A meter, using the 100 Hz dials on both instruments. Then set the CE-21A meter to 0 dBm with the CAL control.

c. Remove the cover of the Probe and very carefully tack solder a precision 75Ω resistor between the input lead and ground (board pins 1 and 5, see Figure 3-24).

d. Remove the patch cord connection and connect the CE-26A to the CE-21A with the 211 Bridging Probe. Adjust R9 for a 0 dBm reading of the CE-21A EXP meter scale.

e. Reconnect patch cord directly between the instruments, set both to 60 kHz and tune for maximum reading. Adjust CE-21A to 0 dBm with CAL control. Replace patch cord connection with the 211 Bridging Probe. Reading should be 0 dBm ± 0.1 dB.

f. Repeat step e. at 9 MHz. Reading should be 0 dBm ± 0.1 dB.

g. Remove tack soldered precision resistor from pins 1, 5 and replace cover.

SECTION 3
PARTS LISTS AND SCHEMATIC DIAGRAMS

INTRODUCTION

3.01 The following parts lists and schematic diagrams have been arranged in order according to the Circuit Reference Series numbers. Refer to paragraph 1.03. Each schematic diagram and parts list is identified with this number. The circuit boards in the instrument are stamped with an identifying Printed Circuit Board number. See Cross Reference, Table 3-1 below.

3.02 Parts list pages are grouped with the schematic diagrams to which they refer. Component identification drawings showing the location of the individual components on the circuit board are placed on the inner sheet of the schematic diagram to which they apply.

Table 3-1. Printed Circuit Board, Circuit Reference Series Cross Reference

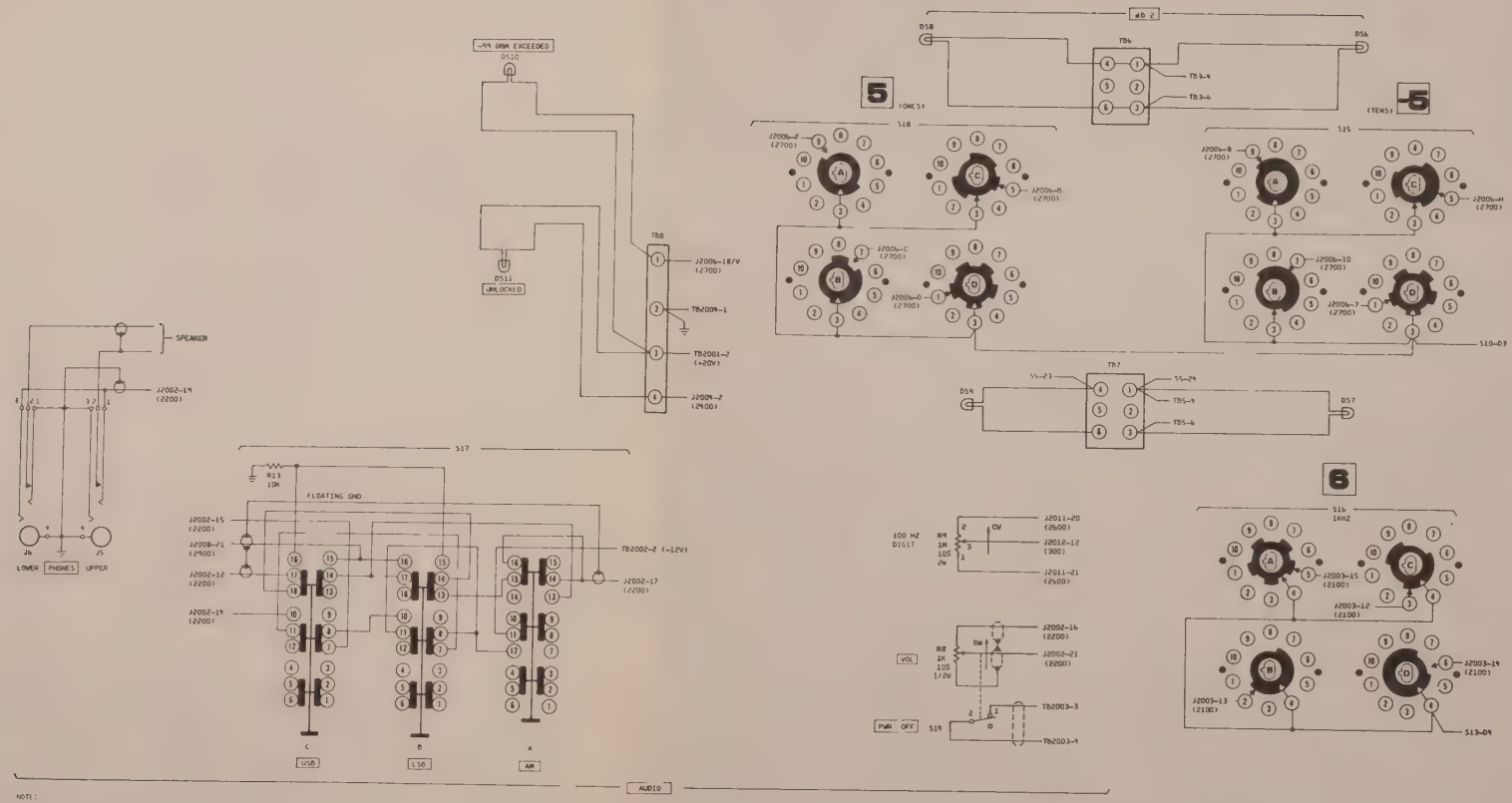
PC Board No.	Title	Ckt. Ref. No.
1780-0110	M.O./Ref. Divider/Divide-by-N	2100
1780-0111	Meter Amplifier/Audio Amplifier	2200
1780-0115	First Mixer	3100
1780-0116	Low Pass Filter	3200
1780-0117	First I.F. Amplifier	3300
1780-0120	Hi-Z Attenuator No. 2	3500
1780-0121	15 dB Attenuator	3600
1780-0122	Voltage Controlled Crystal Oscillator	3700
1780-0123	Second I.F. Amplifier/200 Hz Band Pass Filter	2500
1780-0124	Power Supply Rectifiers	2600
1780-0126	Attenuator Logic	2700
1780-0127	Balanced Input Amplifier	3800
1780-0128	Power Supply Regulators	2800
1780-0129	Impedance Selector	1100
1780-0130	Second I.F. Amplifier/2.3 kHz Band Pass Filter	2900
1780-0132	Sample & Hold/Calibration Amplifier	2400
1780-0133	Voltage Controlled Oscillator	2300
1780-0134	Hi-Z Attenuator No. 1	3900
1780-0142	Second Mixer	3400
---	Front Panel Assembly	1000
---	Chassis Assembly	2000
---	R.F. Casting Assembly	3000
---	Rear Panel	4000

FRONT PANEL. 1000

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
1000	Assembly, Front Panel	7003-0067	Cushman	
	Front Panel	2800-0082	Cushman	
	DIALS			
	Molded Indicator, for S1008	2750-0022-04	Cushman	
	Molded Indicator, for S1010	2750-0022-05	Cushman	
	Molded Indicator, for S1015	2750-0022-02	Cushman	
	Molded Indicator, for S1018	2750-0022-05	Cushman	
	Molded Indicator, for S1009	2750-0022-05	Cushman	
	Molded Indicator, for S1011	2750-0022-05	Cushman	
	Molded Indicator, for S1013	2750-0022-05	Cushman	
	Molded Indicator, for S1016	2750-0022-05	Cushman	
	Molded Indicator, for R1009	2750-0022-03	Cushman	
	HOLDERS			
	Lamp, for T-1 Bulb for DS10	1965-0007	Display Device	101BWXXXRO
	Lamp, for T-1 Bulb for DS11	1965-0007	Display Device	101BWXXXRO
	Lamp, for T-1 Bulb for DS12	1965-0008	Display Device	101BWXXXTA15
	JACKS			
J1/J2	Twin Phone	2586-0008	Trimm	92N-1009B
J3	Coaxial	2586-0009	Trompeter	J3DW
J4	Coaxial	2586-0009	Trompeter	J3DW
J5	Phone, 3-Conductor Single Closed Circuit, Audio	2586-0011	Switchcraft	113B
J6	Phone, 3-Conductor Single Closed Circuit, Audio	2586-0011	Switchcraft	113B
	KNOBS			
	1/2" Round, w/ind line, Blk, R1005	2780-0023	Cushman	
	Round, Black, S1008, 0.713 dia.	2780-0024	Cushman	
	Round, Black, S1010, 0.713 dia.	2780-0024	Cushman	
	Round, Black, S1015, 0.713 dia.	2780-0024	Cushman	
	Round, Black, S1018, 0.713 dia.	2780-0024	Cushman	
	Round, Black, S1009, 0.713 dia.	2780-0024	Cushman	
	Round, Black, S1011, 0.713 dia.	2780-0024	Cushman	
	Round, Black, S1013, 0.713 dia.	2780-0024	Cushman	
	Round, Black, S1016, 0.713 dia.	2780-0024	Cushman	
	Round, Black, R1009, 0.713 dia.	2780-0024	Cushman	
	1/2" round, w/ind line, Black, S1014, R1008	2780-0023	Cushman	
	LAMPS			
DS1	6.3V T-1-3/4 Bulb	2870-0013	Cushman	
DS2	6.3V T-1-3/4 Bulb	2870-0013	Cushman	
DS3	6.3V T-1-3/4 Bulb	2870-0013	Cushman	
DS4	6.3V T-1-3/4 Bulb	2870-0013	Cushman	
DS5	6.3V T-1-3/4 Bulb	2870-0013	Cushman	
DS6	6.3V T-1-3/4 Bulb	2870-0013	Cushman	
DS7	6.3V T-1-3/4 Bulb	2870-0013	Cushman	
DS8	6.3V T-1-3/4 Bulb	2870-0013	Cushman	
DS9	6.3V T-1-3/4 Bulb	2870-0013	Cushman	
DS10	5V 60 ma T-1 Bulb	2870-0014	Display Device	100060-683
DS11	5V 60 ma T-1 Bulb	2870-0014	Display Device	100060-683
DS12	5V 60 ma T-1 Bulb	2870-0014	Display Device	100060-683
	METER			
M1	Level	1402-0023	Cushman	

FRONT PANEL (cont). 1000

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	RESISTORS			
R1-R4	Not Used			
R5	Pot., 1kΩ ±10%, 1/2W	1203-0035	Allen-Bradley	WA4G032S102UA
R6	WW., 0.25Ω ±3%, 3W	1159-0003	Dale	RS-2B
R7	Not Used			
R8/S14	Pot., 1kΩ	1203-0034	Cushman	
R9	Pot., Cer, Met, 1MΩ ±10%, 2W	1203-0033	Cushman	
R10	Not Used			
R11	Comp, 820Ω ±5%, 1/4W	1066-8215	Allen-Bradley	CB8215
R12	Comp, 680Ω, ±5%, 1/4W	1066-6815	Allen-Bradley	CB 5
R13	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R14	Comp, 18Ω ±5%, 1/4W	1066-1805	Allen-Bradley	CB1805
	SHIELD			
	Input Switch Assembly	2657-0030	Cushman	
	SWITCHES			
S1	Pushbutton	1852-0002	Cushman	
S2/S7	Pushbutton	1852-0017	Cushman	
S3	Pushbutton (Assembly)	7011-0015	Cushman	
S4/S5	Pushbutton	1852-0003	Cushman	
S6	Pushbutton	1852-0002	Cushman	
S7	P/O S2			
S8	Rotary, 5 Pole 10 Position	1851-0042	Cushman	P/O 7011-0005
S9	Rotary, 1-MHz Digit	1851-0057	Cushman	P/O 7011-0004
S10	Rotary, 4 Pole 10 Position	1851-0043	Cushman	P/O 7011-0005
S11	3-4-5 & 6 Digit	1851-0027	Cushman	P/O 7011-0004
S12	Not Used			
S13	3-4-5 & 6 Digit	1851-0027	Cushman	P/O 7011-0004
S14/R8	SPST	1203-0034	Cushman	
S15	Rotary, 4 Pole 10 Position	1851-0041	Cushman	P/O 7011-0005
S16	3-4-5 & 6 Digit	1851-0027	Cushman	P/O 7011-0004
S17	Pushbutton	1852-0004	Cushman	
S18	Rotary, 4 Pole 10 Position	1851-0043	Cushman	P/O 7011-0005
	TERMINAL BOARDS			
TB1	Tiepoint	1760-0001	Cinch Jones	51
TB2	Tiepoint	1760-0002	Cinch Jones	51A
TB3	6 Terminal Type	1760-0014	Cushman	
TB4	6 Terminal Type	1760-0014	Cushman	
TB5	6 Terminal Type	1760-0014	Cushman	
TB6	6 Terminal Type	1760-0014	Cushman	
TB7	6 Terminal Type	1760-0014	Cushman	
TB8	4 Lug Type	1760-0019	Cinch Jones	53F
	DIODES			
CR1	Si, 100V PIV	1281-0023	ITT	IN4002



NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 3-1. Front Panel Wiring, sheet 1. 1000

5601**0046

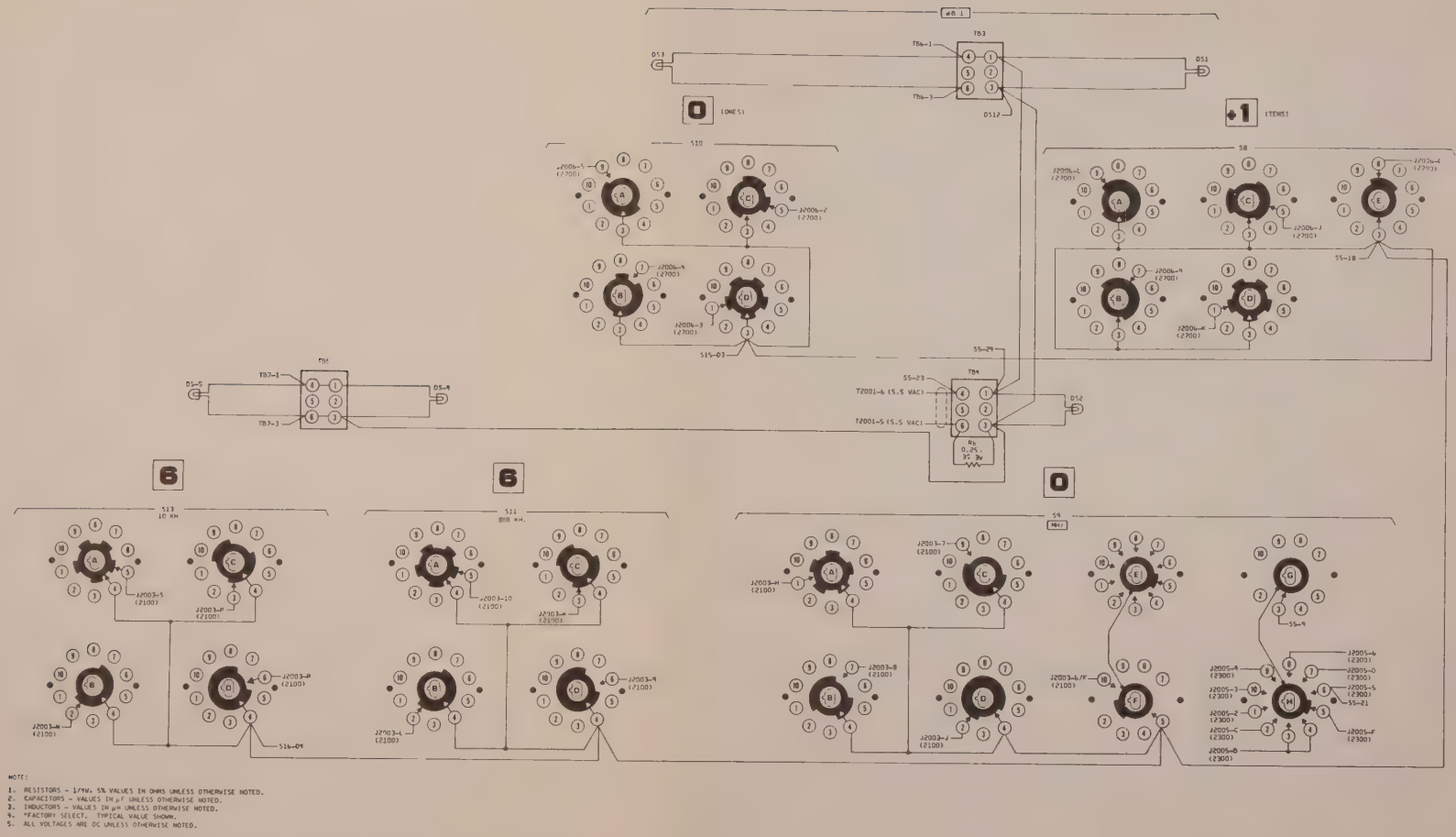


Figure 3-1. Front Panel Wiring, sheet 2. 1000

5601**0046

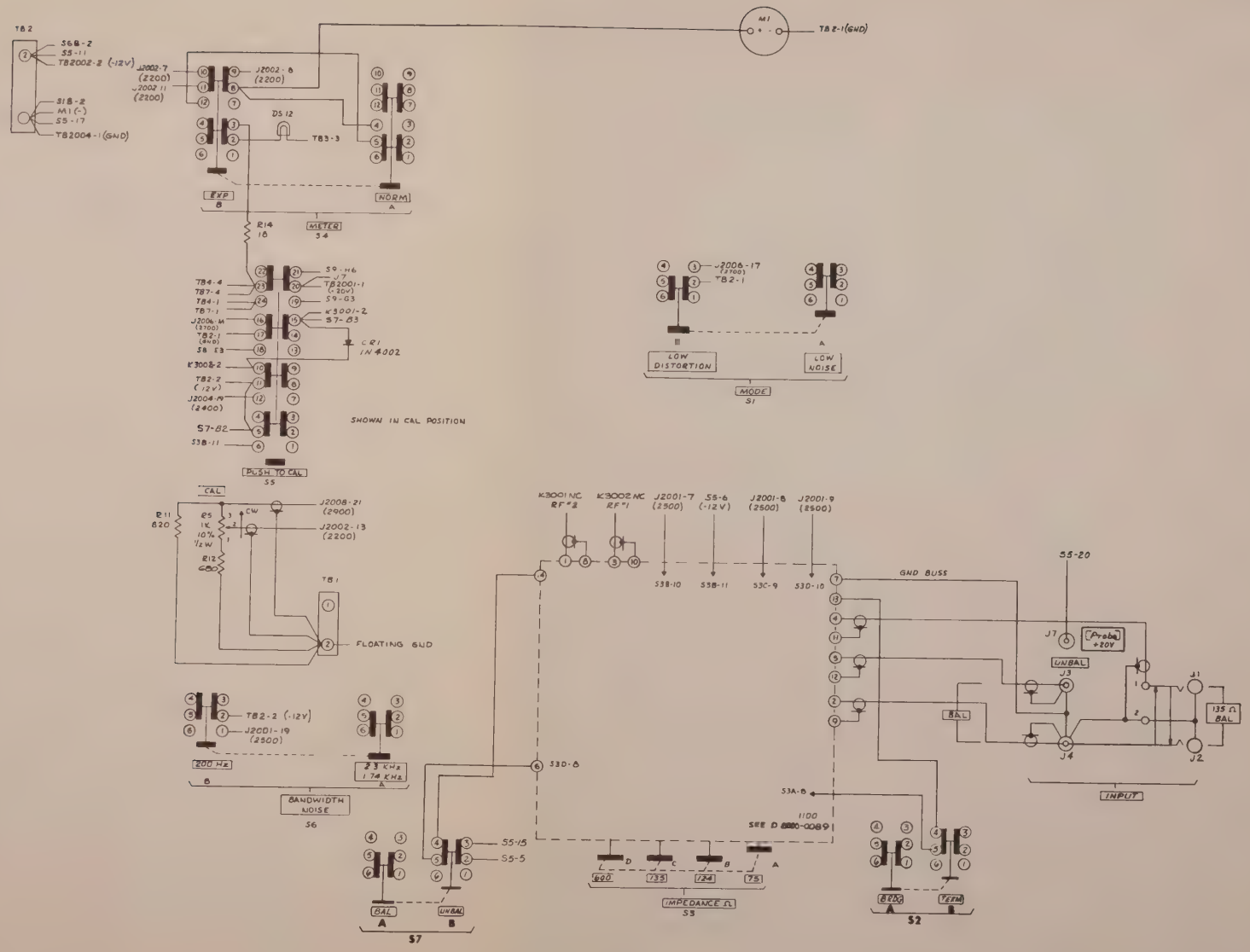
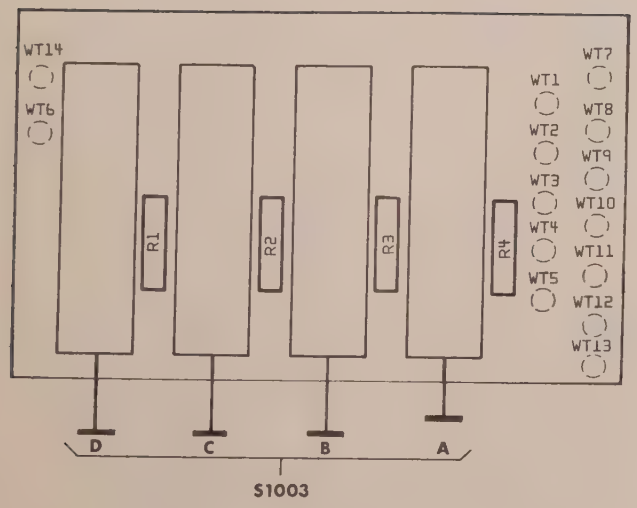
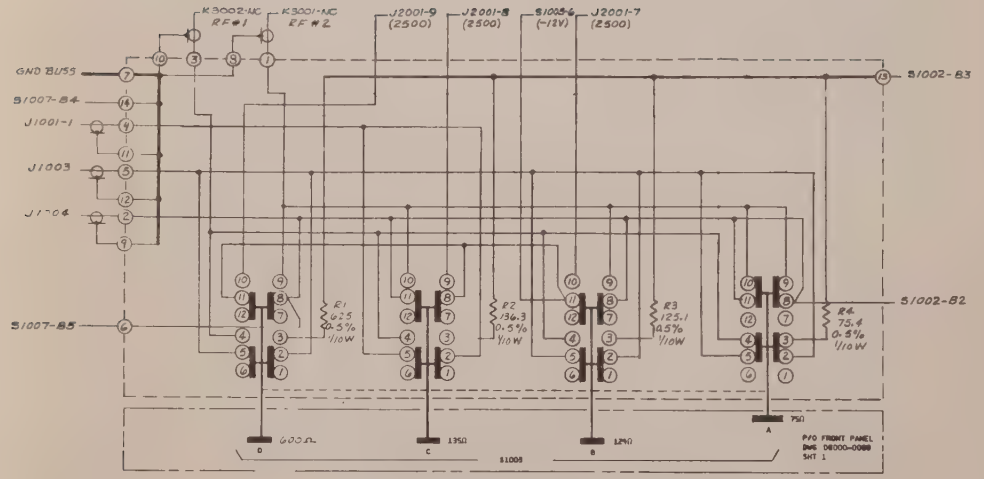


Figure 3-1. Front Panel Wiring, sheet 3. 1000

IMPEDANCE SELECTOR. 1100

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
1100	Board Assy., Impedance Selector	7001-0080	Cushman	
	Board, Printed Circuit	1780-0129	Cushman	
	RESISTORS			
R1	Met. Film, 625Ω ±5%, 0.1W)	1074-0094	Dale	MF 1/10-T-9
R2	Met. Film, 136.3Ω ±0.5%, 0.1 W	1074-0016	Dale	MF 1/10-T-9
R3	Met. Film, 125.1Ω ±0.5%, 0.1 W	1074-0015	Dale	MF 1/10-T-9
R4	Met. Film, 75.4Ω ±0.5%, 0.1 W	1074-0009	Dale	MF 1/10-T-9





NOTE:
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 3-2. Impedance Selector. 1100

MAIN CHASSIS. 2000

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2000	Assembly, Main Chassis	7007-0018	Cushman	
	Main Chassis, Sub. P.C. Board	7007-0022	Cushman	
	CAPACITORS			
C1	Cer, 0.01 μF ±20%, 1400V	1005-0051	Sprague	125L-S10
C2	Cer, 0.002 μF ±20%, 500V	1005-0003	Erie	831060Z5U00202M
C3	Cer, 0.002 μF ±20%, 500V	1005-0003	Erie	831060Z5U00202M
C4	Cer, 0.01 μF ±20%, 1400V	1005-0051	Sprague	125L-S10
	CONNECTORS			
J1	Female, 22-pin	2535-0018	Viking	2VK22S1-1
J2	Female, 22-pin	2535-0018	Viking	2VK22S1-1
J3	Female, Double row, 44-pin	2535-0023	Viking	2VK22D/1-1
J4	Female, 22-pin	2535-0018	Viking	2VK22S1-1
J5	Female, Double row, 44-pin	2535-0023	Viking	2VK22D/1-1
J6	Female, Double row, 44-pin	2535-0023	Viking	2VK22D/1-1
J7	Female, Double row, 44-pin	2535-0023	Viking	2VK22D/1-1
J8	Female, 22-pin	2535-0018	Viking	2VK22D/1-1
J9-J10	Not Used			
J11	Female, 22-pin	2535-0018	Viking	2VK22S1-1
J12	Panel Mount, 14 contact, Recpt.	2535-0031	Amphenol	57-40140
	INDUCTORS			
L1	Choke, 100 μH ±20%, 2 Amp	1585-0040	Miller	B-6021
L2	Choke, 100 μH ±20%, 2 Amp	1585-0040	Miller	B-6021
	TERMINAL BOARDS			
TB1	Tiepoint	1760-0004	Cinch Jones	52
TB2	Tiepoint	1760-0004	Cinch Jones	52
TB3	Tiepoint, 7-pin	1760-0013	Cinch Jones	55C
TB4	Grounding Wheel, #10 x 0.75 Dia.	3766-0018	Jan Engring.	1001
TB5	Stand-Off Terminal, 9/16"	3001-0012	Lerco	6141
TB6	Lug, #10	3766-0013	Federal	1910
	TRANSFORMER			
T1	Power	1575-0009	Cushman	
	TRANSISTORS			
Q1	Si, NPN	1271-0001	RCA	2N3054
Q2	Si, NPN	1271-0001	RCA	2N3054
Q3	Si, NPN	1271-0001	RCA	2N3054
	TRANSISTOR SOCKETS			
XQ1	TO 66, for Q1	2606-0002	UID	PTS-4
XQ2	TO 66, for Q2	2606-0002	UID	PTS-4
XQ3	TO 66, for Q3	2606-0002	UID	PTS-4

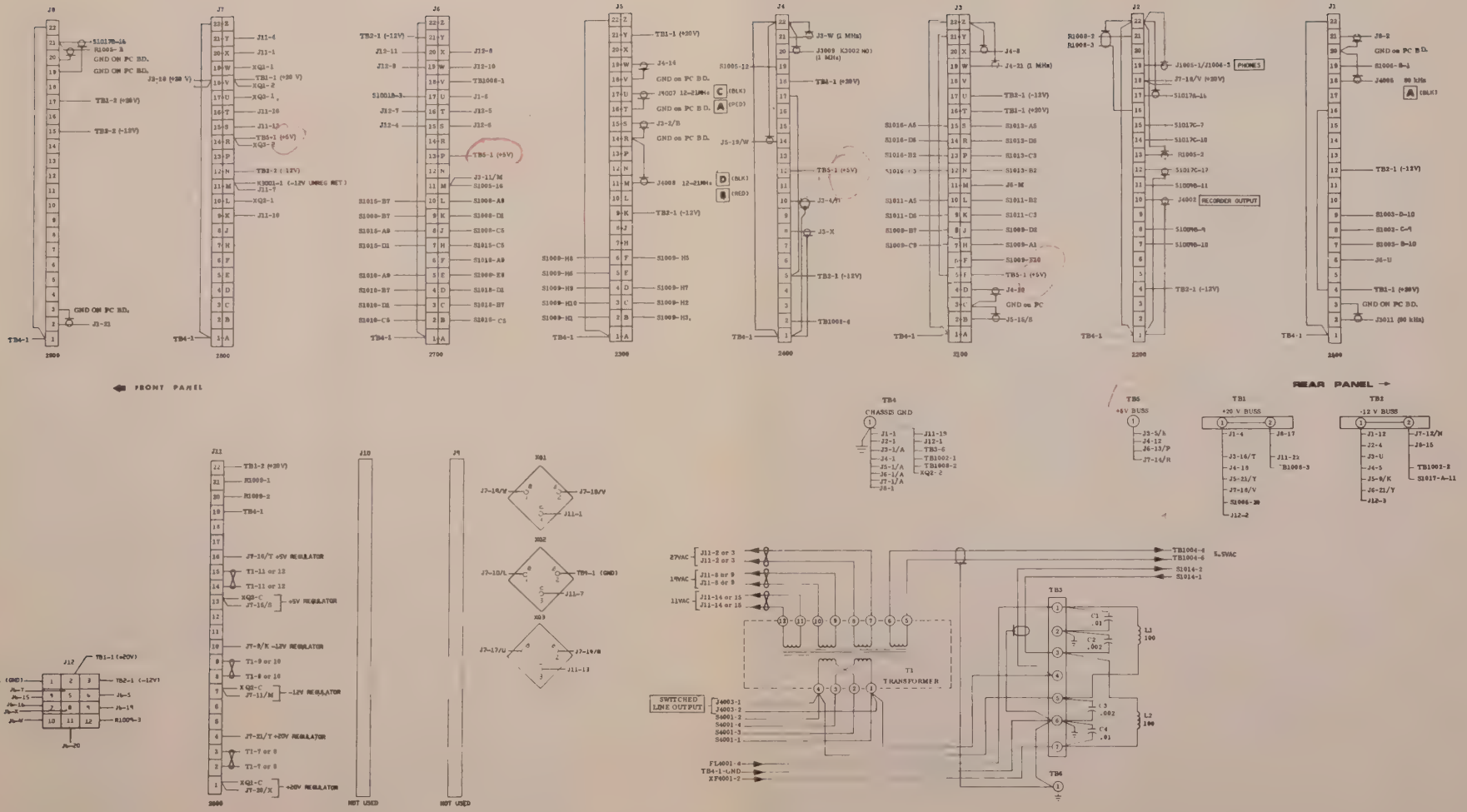


Figure 3-3. Main Chassis Interconnections. 2000

5601**0046

MASTER OSCILLATOR/DIVIDE-BY-N/REFERENCE DIVIDER. 2100

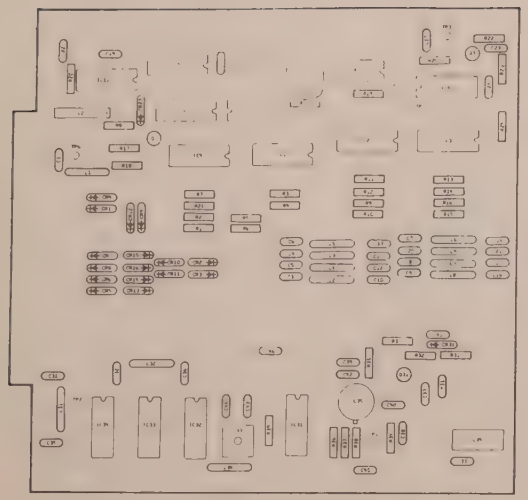
CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2100	Board Assy., Master Oscillator/ Reference Divider/Divide By N	7001-0052	Cushman	
	Board, Printed Circuit	1780-0110	Cushman	
	CAPACITORS			
C1	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C2	Elect., 15 μF ±10%, 25V	1013-0005	Sprague	30D-156G025BB2
C3	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C4	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C5	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C6	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C7	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C8	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C9	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C10	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C11	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C12	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C13	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C14	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C15	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C16	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C17	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C18	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C19	Poly, 0.01 μF ±10%, 200V	1008-0043	Sprague	225P10392XA3
C20	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C21	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C22	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C23	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C24	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C25-C30	Not Used			
C31	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C32	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C33	Mica, 27 pF ±5%, 500V	1002-0008	Elmenco	DM15-E-270J
C34	Var, Piston Glass, 0.8 -12 pF,750V	1001-0007	JFD	VC31GWY
C35	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C36	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C37	Polyester, 0.0012 μF ±10%, 100V	1008-0016	Sprague	225P12291WA3
C38	Mica, 1000 pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C39	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C40	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C41	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C42	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C43	Mica, 680 pF ±5%, 500V	1002-0022	Elmenco	DM15-F-681J
C44	Mica, 1000 pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C45	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C46	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
	CRYSTAL			
Y31	2.0 MHz	2035-0008	Cushman	
	DIODES			
CR1	Ge, Signal	1282-0005	ITT	G633
CR2	Ge, Signal	1282-0005	ITT	G633
CR3	Ge, Signal	1282-0005	ITT	G633
CR4	Ge, Signal	1282-0005	ITT	G633
CR5	Ge, Signal	1282-0005	ITT	G633

MASTER OSCILLATOR/DIVIDE-BY-N/REFERENCE DIVIDER (cont). 2100

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
CR6	Ge, Signal	1282-0005	ITT	G633
CR7	Ge, Signal	1282-0005	ITT	G633
CR8	Ge, Signal	1282-0005	ITT	G633
CR9	Ge, Signal	1282-0005	ITT	G633
CR10	Ge, Signal	1282-0005	ITT	G633
CR11	Ge, Signal	1282-0005	ITT	G633
CR12	Ge, Signal	1282-0005	ITT	G633
CR13	Ge, Signal	1282-0005	ITT	G633
CR14	Ge, Signal	1282-0005	ITT	G633
CR15	Ge, Signal	1282-0005	ITT	G633
CR16	Ge, Signal	1282-0005	ITT	G633
CR17-CR22	Not Used			
CR23	Ge, Signal	1282-0005	ITT	G633
CR24-CR30	Not Used			
CR31	Si, Zener	1281-0007	Continental Device	1N957
	INDUCTORS			
L1	Choke, 12 μH ±10%	1585-0011	Delevan	1537-38
L2	Choke, 47 μH ±5%	1585-0010	Delevan	1537-60
L3	Choke, 47 μH ±5%	1585-0010	Delevan	1537-60
L4	Choke, 47 μH ±5%	1585-0010	Delevan	1537-60
L5	Choke, 47 μH ±5%	1585-0010	Delevan	1537-60
L6	Choke, 47 μH ±5%	1585-0010	Delevan	1537-60
L7	Choke, 47 μH ±5%	1585-0010	Delevan	1537-60
L8	Choke, 47 μH ±5%	1585-0010	Delevan	1537-60
L9	Choke, 47 μH ±5%	1585-0010	Delevan	1537-60
L10	Not Used			
L11-L30	Not Used			
L31	Choke, 12 μH ±10%	1585-0011	Delevan	1537-38
L32	Choke, 47 μH ±5%	1585-0010	Delevan	1537-60
L33	Var, 35 - 60 μH	1596-0006	Cushman	
L34	Choke, 12 μH ±10%	1585-0011	Delevan	1537-38
	INTEGRATED CIRCUITS			
IC1	Presettable Decade	2025-0016	TI	SN74196N
IC2	Presettable Decade	2025-0016	TI	SN74196N
IC3	Presettable Decade	2025-0016	TI	SN74196N
IC4	Presettable Decade	2025-0016	TI	SN74196N
IC5	TTL NAND Gate	2025-0003	TI	SN7400
IC6	TTL AND Gate	2025-0017	TI	SN74H11N
IC7	TTL Dual Flip-Flop	2025-0005	TI	SN7476N
IC8	TTL Dual Flip-Flop	2025-0023	TI	SN74H72N
IC9	TTL NAND Gate	2025-0004	TI	SN7430N
IC10	Presettable Decade	2025-0016	TI	SN74196N
IC11	Quad 2-Input NOR Gate	2025-0019	Signetics	SP380A
IC12-IC30	Not Used			
IC31	TTL Dual Flip-Flop	2025-0007	TI	SN7472N
IC32	TTL Decade Counter	2025-0002	TI	SN7490N
IC33	TTL Decade Counter	2025-0002	TI	SN7490N
IC34	TTL Decade Counter	2025-0002	TI	SN7490N
IC35	Ampl, RF	2025-0012	RCA	CA3028A
	RESISTORS			
R1	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R2	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R3	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R4	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725

MASTER OSCILLATOR/DIVIDE-BY-N/REFERENCE DIVIDER (cont). 2100

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R5	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R6	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R7	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R8	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R9	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R10	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R11	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R12	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R13	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R14	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R15	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R16	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R17	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R18	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R19	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R20	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R21	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R22	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley	CB1225
R23	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R24	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R25	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley	CB1225
R26	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R27-R30	Not Used			
R31	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R32	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R33	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R34	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R35	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R36	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R37	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R38	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R39	Comp, 18kΩ ±5%, 1/4W	1066-1835	Allen-Bradley	CB1835
	TRANSISTORS			
Q1	Si, NPN	1272-0016	Fairchild	2N4275
Q2	Si, NPN	1272-0016	Fairchild	2N4275
Q3	Si, NPN	1272-0022	Fairchild	2N3563
Q4-Q30	Not Used			
Q31	Si, NPN	1272-0016	Fairchild	2N4275



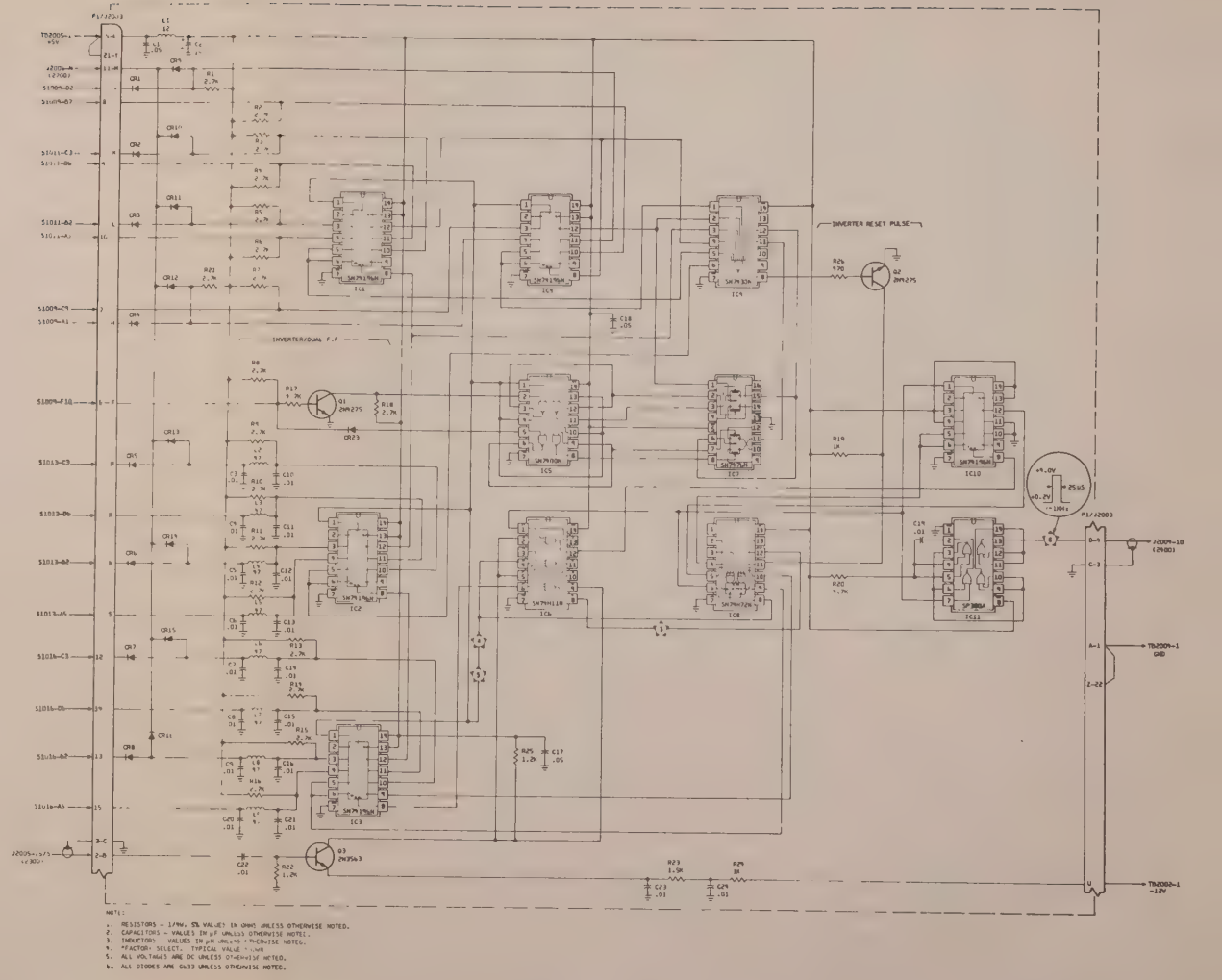
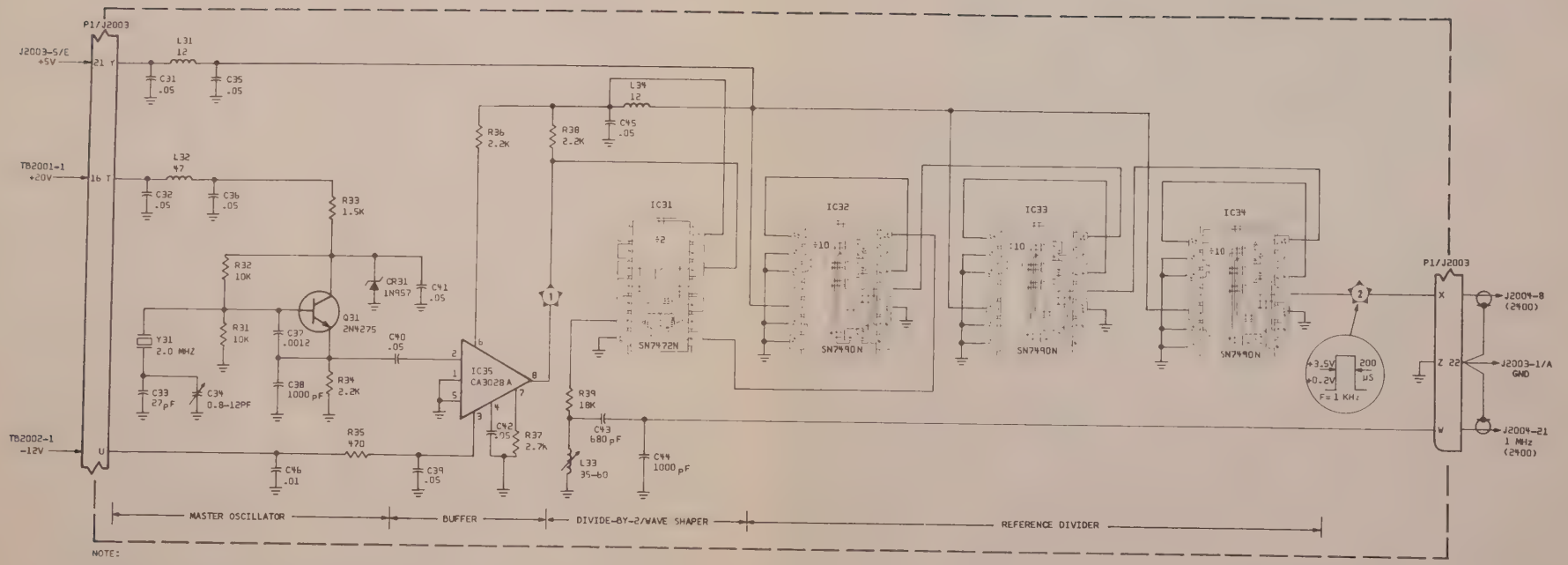

INVERTER RESET PULSE
INVERTER/DUAL F-F
NOTE:
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN µF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN µH UNLESS OTHERWISE NOTED.
4. *FACTOR- SELECT. TYPICAL VALUE SHOWN
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
6. ALL DIODES ARE 6A33 UNLESS OTHERWISE NOTED.

Figure 3-4. Master Oscillator/Divide-by-N/Reference Divider, sheet 1. 2100



NOTE:

1. RESISTORS – 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS – VALUES IN µF UNLESS OTHERWISE NOTED.
3. INDUCTORS – VALUES IN µH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 3-4. Master Oscillator/Divide-by-N/Reference Divider, sheet 2. 2100

5601-0046

METER AMPLIFIERS/AUDIO AMPLIFIERS. 2200

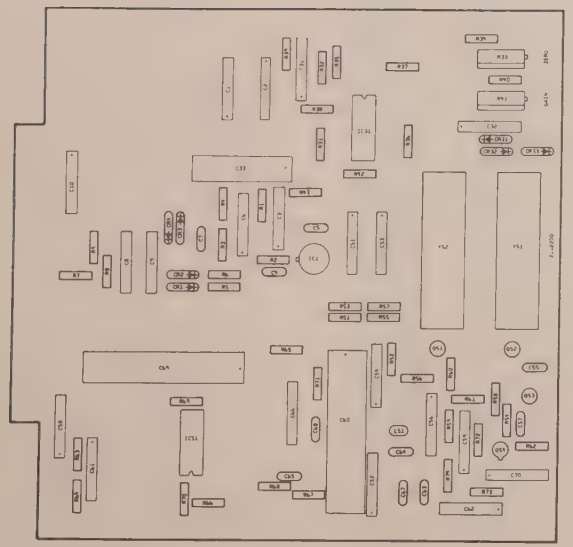
CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2200	Board Assy., Meter Amplifier/ Audio Amplifier	7001-0053	Cushman	
	Board, Printed Circuit	1780-0111	Cushman	
	CAPACITORS			
C1	Elect., 100 µF ±10%. 25V	1013-0003	Sprague	30D-107G025DD2
C2	Elect., 100 µf ±10%, 25V	1013-0003	Sprague	30D-107G025DD2
C3	Elect., 1.0 µF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C4	Mica, 75 pF ±5%, 500V	1002-0025	Elmenco	DM15-E-750J
C5	Cer, 3.3 pF ±0.25%, 500V	1005-0011	Erie	301-000-C0J0-339C
C6	Elect., 15 µF ±10%, 25V	1013-0005	Sprague	30D-156G025BB2
C7	Polyester, 0.1 µF ±10%, 100V	1008-0031	Sprague	225P-10491WA3
C8	Polyester, 0.22 µF ±10%, 75V	1008-0047	Sprague	225P-2249R75Z
C9	Polyester, 0.22 µF ±10%, 75V	1008-0047	Sprague	225P-2249R75Z
C10	Elect., 100 µF ±10%, 25V	1013-0003	Sprague	30D-107G025DD2
C11-C30	Not Used			
C31	Elect., 1.0 µF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C32	Elect., 1.0 µF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C33	Elect., 500 µF +100 -10%, 15V	1013-0014	San Fernando	MAC15.501
C34-C50	Not Used			
C51	Elect., 15 µF ±10%, 25V	1013-0005	Sprague	30D-156G025BB2
C52	Elect., 1.0 µF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C53	Elect., 15 µF ±10%, 25V	1013-0005	Sprague	30D-156G025BB2
C54	Elect., 1.0 µF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C55	Mica, 200 pF ±5%, 500V	1002-0042	Elmenco	DM15-F-201J
C56	Elect., 15 µF ±10%, 25V	1013-0005	Sprague	30D-156G025BB2
C57	Cer, 0.05 µF +80 -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C58	Elect., 1.0 µF +75 -10%, 25V	1013-0004	Sprague	30D-105G025BA2
C59	Elect., 15 µF +75 -10%, 12V	1013-0015	Sprague	30D-156G012BA2
C60	Elect., 1000 µF +150 -10%, 25V	1014-0006	Matsushita	ECE-B25V1000N
C61	Elect., 1.0 µF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C62	Elect., 1.0 µF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C63	Polyester, 0.027 µF ±10%, 100V	1008-0032	Sprague	225P27391WA3
C64	Mica, 96 pF ±1%, 500V	1002-0049	Elmenco	DM15-F-960F
C65	Mica, 1000 pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C66	Elect., 100 µF +75 -10%, 12V	1013-0011	Sprague	30D-107G012CC2
C67	Polyester, 0.0012 µF ±10%, 100V	1008-0016	Sprague	225P12291WA3
C68	Cer, 0.05 µF +80 -20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C69	Elect., 500 µF +100 -10%. 25V	1014-0002	Richey	JA-13-500-25-8-P
C70	Elect., 1.0 µF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
	CRYSTALS			
Y1-Y50	Not Used			
Y51	78.0 kHz	2035-0006	Cushman	
Y52	82.0 kHz	2035-0007	Cushman	
	DIODES			
CR1	Si, Zener	1281-0034	Motorola	1N749A
CR2	Si, Zener	1281-0034	Motorola	1N749A
CR3	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
CR4	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
CR5-CR30	Not Used			
CR31	Ge, Signal	1282-0005	ITT	G633
CR32	Si, High Speed	1281-0013	Transitron	1N3064
CR33	Si, High Speed	1281-0013	Transitron	1N3064

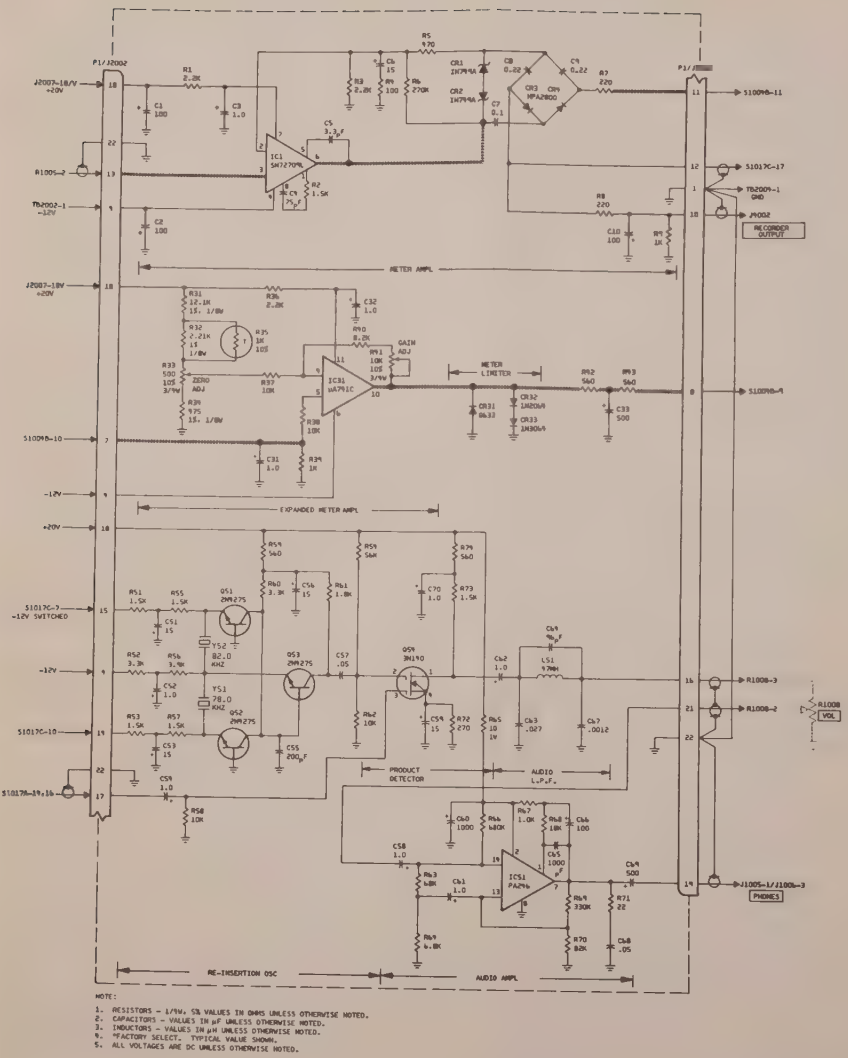
METER AMPLIFIERS/AUDIO AMPLIFIERS. 2200

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	INDUCTOR			
L1-L50	Not Used			
L51	Choke, RF, 47 mH	1585-0044	Cambion	3635-57
	INTEGRATED CIRCUITS			
IC1	Ampl, Operational	2025-0014	TI	SN72709L
IC2	Not Used			
IC3	Not Used			
IC4	Not Used			
IC5	Not Used			
IC6-IC30	Not Used			
IC31	Op-Amplifier, High Performance	2025-0022	TI	72741N
IC32-IC50	Not Used			
IC51	Ampl, Audio, 5W	2025-0024	GE	PA246
	RESISTORS			
R1	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R2	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R3	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R4	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R5	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R6	Comp, 270kΩ ±5%, 1/4W	1066-2745	Allen-Bradley	CB2745
R7	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley	CB2215
R8	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley	CB2215
R9	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R10-R30	Not Used			
R31	Met. Film, 12.1kΩ ±1%, 1/8W	1075-0011	Electra	MF5C-D-1212-F
R32	Met. Film, 2.21kΩ ±1%, 1/8W	1075-0010	Electra	MF5C-D-2211-F
R33	Trimmer,Cer,Met,500Ω±10%,3/4W	1215-0011	Helitrim	89WR500
R34	Met. Film, 475Ω ±1%, 1/8W	1075-0023	Electra	MF5C-D-4750-F
R35	Thermistor, 1kΩ ±10%	1253-0002	Veco	31E2
R36	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R37	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R38	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R39	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R40	Comp, 8.2kΩ ±5%, 1/4W	1066-8225	Allen-Bradley	CB8225
R41	Trimmer,Cer,Met,10kΩ±10%,3/4W	1215-0014	Helitrim	89WR10K
R42	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R43	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R44-R50	Not Used			
R51	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R52	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R53	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R54	Comp, 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R55	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R56	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R57	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R58	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R59	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R60	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R61	Comp, 1.8kΩ ±5%, 1/4W	1066-1825	Allen-Bradley	CB1825
R62	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R63	Comp, 68kΩ ±5%, 1/4W	1066-6835	Allen-Bradley	CB6835
R64	Comp, 6.8kΩ ±5%, 1/4W	1066-6825	Allen-Bradley	CB6825
R65	Comp, 10Ω ±5%, 1W	1068-1005	Allen-Bradley	GB1005

METER AMPLIFIERS/AUDIO AMPLIFIERS. 2200

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R66	Comp, 680kΩ ±5%, 1/4W	1066-6845	Allen-Bradley	CB6845
R67	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R68	Comp, 18kΩ ±5%, 1/4W	1066-1835	Allen-Bradley	CB1835
R69	Comp, 330kΩ ±5%, 1/4W	1066-3345	Allen-Bradley	CB3345
R70	Comp, 82kΩ ±5%, 1/4W	1066-8235	Allen-Bradley	CB8235
R71	Comp, 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R72	Comp, 270Ω ±5%, 1/4W	1066-2715	Allen-Bradley	CB2715
R73	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R74	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
	TRANSISTORS			
Q1-Q50	Not Used			
Q51	Si, NPN	1272-0016	Fairchild	2N4275
Q52	Si, NPN	1272-0016	Fairchild	2N4275
Q53	Si, NPN	1272-0016	Fairchild	2N4275
Q54	Si, MOS FET, Dual Gate	1272-0028	RCA	3N140





NOTE:
1. RESISTORS - 1/8W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 3-5. Meter Amplifiers/Audio Amplifiers. 2200

VOLTAGE CONTROLLED OSCILLATOR. 2300

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2300	Board Assy., Voltage Controlled Oscillator (VCO)	7001-0091	Cushman	
	Board, Printed Circuit	1780-0133	Cushman	
	CAPACITORS			
C1	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C2	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C3	Tant., 10μF ±10%, 20V	1011-0007	Kemet	K10C20K
C4	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C5	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C6	Cer., 0.1μF ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C7	Mica, 5pF ±0.5pF, 500V	1002-0028	Elmenco	DM15-C-050D
C8	Mica, 36pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C9	Mica, 220pF±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C10	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C11	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C12	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C13	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C14	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C15	Tant., 10μF ±10%, 20V	1011-0007	Kemet	K10C20K
C16	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C17	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C18	Cer., 0.01μF ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C19	Mica, 10pF ±5%, 500V	1002-0016	Elmenco	DM15-C-100J
C20	Mica, 36pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C21	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C22	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C23	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C24	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C25	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C26	Cer, 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C27	Tant., 10μF ±10%, 20V	1011-0007	Kemet	K10C20K
C28	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C29	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C30	Cer, 0.1μF ±10%, 100V	1005-0064	Aerovox	CK06BX104J
C31	Mica, 15pF ±5%, 500V	1002-0001	Elmenco	DM15-C-150J
C32	Mica, 36pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C33	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C34	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C35	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C36	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C37	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C38	Cer, 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C39	Tant., 10μF ±10%, 20V	1011-0007	Kemet	K10C20K
C40	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C41	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C42	Cer., 0.1μF ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C43	Mica, 18pF ±5%, 500V	1002-0014	Elmenco	DM15-C-180J
C44	Mica, 36pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C45	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C46	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C47	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C48	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C49	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C50	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z

VOLTAGE CONTROLLED OSCILLATOR (cont). 2300

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
C51	Tant., 10μF ±10%, 20V	1011-0007	Kemet	K10C20K
C52	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C53	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C54	Cer., 0.1μF ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C55	Mica, 22 pF ±5%, 500V	1002-0023	Elmenco	DM15-C-220J
C56	Mica, 36pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C57	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C58	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C59	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C60	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C61	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C62	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C63	Tant., 10μF ±10%, 20V	1011-0007	Kemet	K10C20K
C64	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C65	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C66	Cer., 0.01μF ±10%, 100V	1005-0007	Aerovox	CK06BX104K
C67	Mica, 27pF ±5%, 500V	1002-0008	Elmenco	DM15-E-270J
C68	Mica, 36pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C69	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C70	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C71	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C72	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C73	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C74	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C75	Tant., 10μF ±10%, 20V	1011-0007	Kemet	K10C20K
C76	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C77	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C78	Cer., 0.01μF ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C79	Mica, 27pF ±5%, 500V	1002-0008	Elmenco	DM15-E-270J
C80	Mica, 36pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C81	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C82	Mica, 1000pF ±5%, 500V	1002-0015	Elmenco	DM15-F-102J
C83	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C84	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C85	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C86	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C87	Tant., 10μF ±10%, 20V	1011-0007	Kemet	K10C20K
C88	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C89	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C90	Cer., 0.1μF ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C91	Mica, 39pF ±5%, 500V	1002-0018	Elmenco	DM15-E-390J
C92	Mica, 36pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C93	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C94	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C95	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C96	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C97	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C98	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C99	Tant., 10μF ±10%, 20V	1011-0007	Kemet	K10C20K
C100	Mica, 100pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J

VOLTAGE CONTROLLED OSCILLATOR (cont). 2300

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
C101	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C102	Cer., 0.1μF ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C103	Mica, 33pF ±5%, 500V	1002-0024	Elmenco	DM15-E-330J
C104	Mica, 36pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C105	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C106	Mica, 1000pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C107	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C108	Mica, 220pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C109	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C110	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C111	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C112	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C113	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C114	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C115	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C116	Cer., 0.01μF +80%-20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C117	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C118	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C119	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C120	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C121	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C122	Cer., 0.05μF +80%-20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C123	Elect., 100μF ±10%, 25V	1013-0003	Sprague	30D-107G025DD2
	DIODES			
CR1	Var, 100pF	1281-0037	Motorola	MV1650
CR2	Var, 100pF	1281-0037	Motorola	MV1650
CR3	Var, 100pF	1281-0037	Motorola	MV1650
CR4	Var, 100pF	1281-0037	Motorola	MV1650
CR5	Var, 100pF	1281-0037	Motorola	MV1650
CR6	Var, 100pF	1281-0037	Motorola	MV1650
CR7	Var, 100pF	1281-0037	Motorola	MV1650
CR8	Var, 100pF	1281-0037	Motorola	MV1650
CR9	Var, 100pF	1281-0037	Motorola	MV1650
CR10	Var, 100pF	1281-0037	Motorola	MV1650
CR11	Var, 100pF	1281-0037	Motorola	MV1650
CR12	Var, 100pF	1281-0037	Motorola	MV1650
CR13	Var, 100pF	1281-0037	Motorola	MV1650
CR14	Var, 100pF	1281-0037	Motorola	MV1650
CR15	Var, 100pF	1281-0037	Motorola	MV1650
CR16	Var, 100pF	1281-0037	Motorola	MV1650
CR17	Var, 100pF	1281-0037	Motorola	MV1650
CR18	Var, 100pF	1281-0037	Motorola	MV1650
	INDUCTORS			
L1	Choke, 2-1/2 Turns, Wide Band	1586-0003	Ferroxcube	VK20020/4B
L2	Var., 2.8μH ±5%	1596-0054	Dale	1DH-1041
L3	Var., 2.4μH ±5%	1596-0056	Dale	1DH-1041
L4	Var., 2.2μH ±5%	1596-0038	Dale	1DH-1041-8
L5	Var., 1.7μH ±5%	1596-0046	Dale	1DH-1041

VOLTAGE CONTROLLED OSCILLATOR (cont). 2300

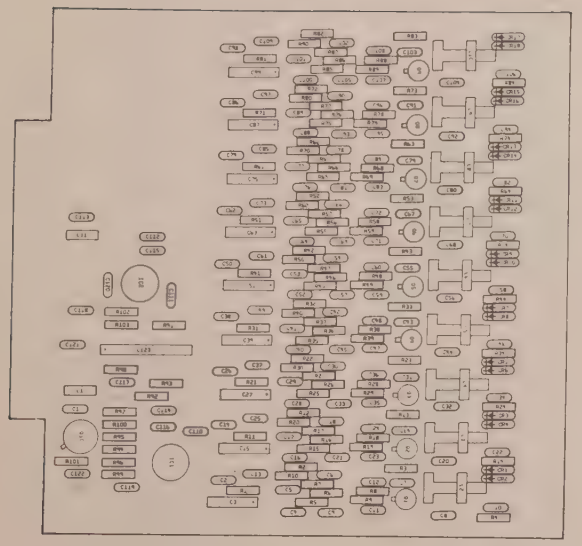
CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
L6	Var., 1.4μH ±5%	1596-0045	Dale	1DH-1041
L7	Var., 1.2μH ±5%	1596-0044	Dale	1DH-1041-26
L8	Var., 1.2μH ±5%	1596-0044	Dale	1DH-1041-26
L9	Var., 0.9μH ±5%	1596-0043	Dale	1DH-1041
L10	Var., 0.9μH ±5%	1596-0043	Dale	1DH-1041
L11	Choke, 2-1/2 Turns, Wide Band	1586-0003	Ferroxcube	VK20020/4B
	INTEGRATED CIRCUITS			
IC1	Ampl., UHF Linear Circuit	2025-0030	Amelco	901CE
IC2	Ampl., RF	2025-0012	RCA	CA3028A
	RESISTORS			
R1	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R2	Comp., 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R3	Comp., 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley	CB4735
R4	Comp., 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R5	Comp., 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R6	Comp., 5.1kΩ ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R7	Comp., 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R8	Comp., 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R9	Comp., 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R10	Comp., 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R11	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R12	Comp., 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R13	Comp., 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley	CB4735
R14	Comp., 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R15	Comp., 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R16	Comp., 5.1kΩ ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R17	Comp., 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R18	Comp., 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R19	Comp., 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R20	Comp., 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R21	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R22	Comp., 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R23	Comp., 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley	CB4735
R24	Comp., 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R25	Comp., 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R26	Comp., 5.1kΩ ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R27	Comp., 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R28	Comp., 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R29	Comp., 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R30	Comp., 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R31	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R32	Comp., 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R33	Comp., 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley	CB4735
R34	Comp., 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R35	Comp., 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R36	Comp., 5.1kΩ ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R37	Comp., 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R38	Comp., 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R39	Comp., 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R40	Comp., 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225

VOLTAGE CONTROLLED OSCILLATOR (cont). 2300

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R41	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R42	Comp., 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R43	Comp., 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley	CB4735
R44	Comp., 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R45	Comp., 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R46	Comp., 5.1kΩ ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R47	Comp., 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R48	Comp., 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R49	Comp., 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R50	Comp., 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R51	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R52	Comp., 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R53	Comp., 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley	CB4735
R54	Comp., 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R55	Comp., 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R56	Comp., 5.1kΩ ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R57	Comp., 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R58	Comp., 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R59	Comp., 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R60	Comp., 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R61	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R62	Comp., 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R63	Comp., 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley	CB4735
R64	Comp., 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R65	Comp., 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R66	Comp., 5.1kΩ ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R67	Comp., 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R68	Comp., 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R69	Comp., 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R70	Comp., 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R71	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R72	Comp., 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R73	Comp., 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley	CB4735
R74	Comp., 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R75	Comp., 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R76	Comp., 5.1kΩ ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R77	Comp., 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R78	Comp., 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R79	Comp., 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R80	Comp., 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R81	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R82	Comp., 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R83	Comp., 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley	CB4735
R84	Comp., 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R85	Comp., 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R86	Comp., 5.1kΩ ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R87	Comp., 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R88	Comp., 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R89	Comp., 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R90	Comp., 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225

VOLTAGE CONTROLLED OSCILLATOR (cont). 2300

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R91	Comp., 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R92	Comp., 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R93	Comp., 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R94	Comp., 270Ω ±5%, 1/4W	1066-2715	Allen-Bradley	CB2715
R95	Comp., 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R96	Comp., 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley	CB5625
R97	Comp., 51Ω ±5%, 1/4W	1066-5105	Allen-Bradley	CB5105
R98	Comp., 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R99	Comp., 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley	CB2215
R100	Comp., 150Ω ±5%, 1/4W	1066-1515	Allen-Bradley	CB1515
R101	Comp., 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R102	Comp., 51Ω ±5%, 1/4W	1066-5105	Allen-Bradley	CB5105
R103	Comp., 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
	TRANSISTORS			
Q1	Si, NPN	1272-0067	RCA	2N5179
Q2	Si, NPN	1272-0067	RCA	2N5179
Q3	Si, NPN	1272-0067	RCA	2N5179
Q4	Si, NPN	1272-0067	RCA	2N5179
Q5	Si, NPN	1272-0067	RCA	2N5179
Q6	Si, NPN	1272-0067	RCA	2N5179
Q7	Si, NPN	1272-0067	RCA	2N5179
Q8	Si, NPN	1272-0067	RCA	2N5179
Q9	Si, NPN	1272-0067	RCA	2N5179
Q10	Si, NPN	1271-0005	RCA	2N3866



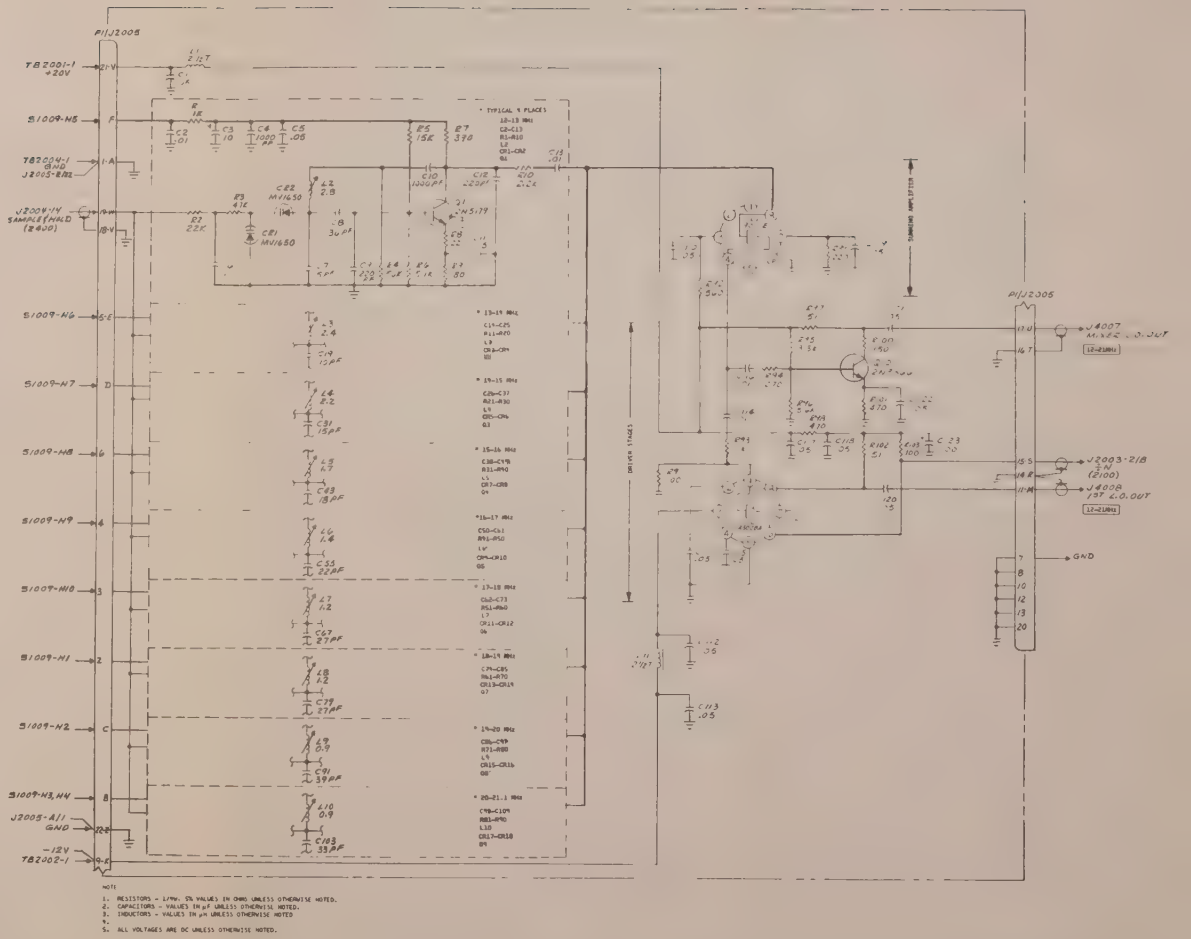


Figure 3-6. Voltage Controlled Oscillator. 2300

5601-0046

SAMPLE AND HOLD/CALIBRATION AMPLIFIER. 2400

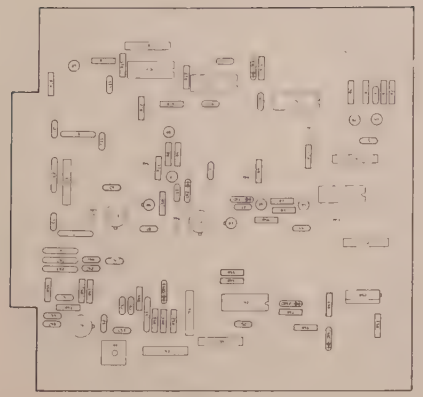
CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2400	Board Assy., Sample and Hold/ Calibration Amplifier	7001-0090	Cushman	
	Board, Printed Circuit	1780-0132	Cushman	
	CAPACITORS			
C1	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C2	Elect., 25 μF +75 -10%, 25V	1013-0010	Sprague	30D-256G025CB2
C3	Not Used			
C4	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C5	Polyester, 0.047 μF ±10%, 100V	1008-0049	Sprague	225P47391WA3
C6	Mica, 1000 pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C7	Polyester, 0.0082 μF ±10%, 100V	1008-0015	Sprague	225P82291WA3
C8	Mica,1000 pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C9	Polyester, 0.1 μF ±10%, 100V	1008-0031	Sprague	225P10491WA3
C10	Elect., 25 μF +75 -10%, 25V	1013-0010	Sprague	30D-256G025CB2
C11	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C12	Mica, 22 pF ±5%, 500V	1002-0023	Elmenco	DM15-C-220J
C13	Mica, 22 pF ±5%, 500V	1002-0023	Elmenco	DM15-C-220J
C14	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C15	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C16	Polyester, 0.027 μF ±10%, 100V	1008-0032	Sprague	225P27391WA3
C17	Polyester, 0.027 μF ±10%, 100V	1008-0032	Sprague	225P27391WA3
C18	Elect., 15 μF +75 -10%, 12V	1013-0015	Sprague	30D-156G012BA2
C19	Mica, 330 pF ±5%, 500V	1002-0032	Elmenco	DM15-F-331J
C20	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C21-C40	Not Used			
C41	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C42	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C43	Elect., 25 μF +75 -10%, 25V	1013-0010	Sprague	30D-256G025CB2
C44	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C45	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C46	Elect., 25 μF +75 -10%, 25V	1013-0010	Sprague	30D-256G025CB2
C47	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C48	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C49	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C50	Mica, 1000 pF ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C51	Mica, 2700 pF ±5%, 500V	1002-0081	Elmenco	DM19-C-272J
C52	Mica, 820 pF ±5%, 300V	1002-0039	Elmenco	DM15-F-821J
C53	Mica, 33 pF ±5%, 500V	1002-0024	Elmenco	DM15-E-330J
C54	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
	DIODES			
CR1	Ge, Signal	1282-0005	ITT	G633
CR2	Ge, Signal	1282-0005	ITT	G633
CR3	Ge, Signal	1282-0005	ITT	G633
CR4-CR40	Not Used			
CR41	Si, Zener, 6.2V ±5%	1281-0038	Transitron	'927
CR42	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
CR43	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
	INDUCTORS			
L1	Choke, 1 mH ±5%	1585-0020	Delevan	2500-28
L2	Choke, 2-1/2 turns, Wide Band	1586-0003	Ferroxcube	VK20020/4B
L3	Choke, 2-1/2 turns, Wide Band	1586-0003	Ferroxcube	VK20020/4B
L4-L40	Not Used			
L41	Choke, 200 μH ±5%	1585-0018	Delevan	1537-92

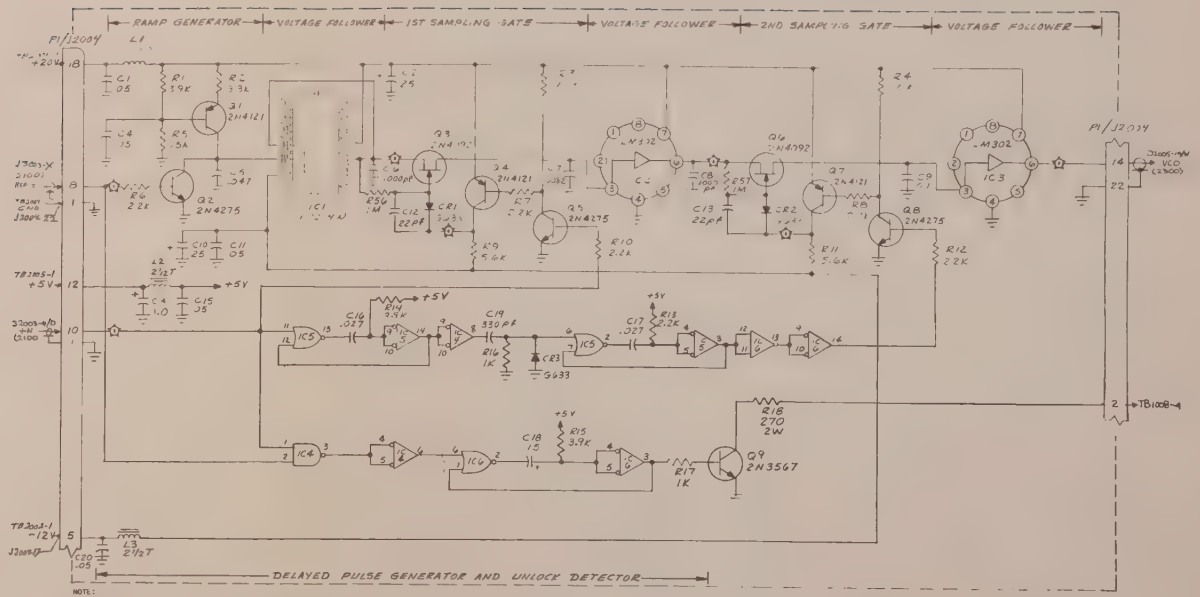
SAMPLE AND HOLD/CALIBRATION AMPLIFIER (cont). 2400

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
L42	Choke, 220 μH ±5%	1585-0018	Delevan	1537-92
L43	Choke, 220 μH ±5%	1585-0018	Delevan	1537-92
L44	Var, 35 - 60 μH	1596-0006	Cushman	
L45	Choke, 2.2 mH ±5%	1585-0004	Miller	70F223A1
	INTEGRATED CIRCUITS			
IC1	Ampl, Operational	2025-0022	TI	SN72741N
IC2	Voltage Follower	2025-0029	National Semi-conductor	LM302
IC3	Voltage Follower	2025-0029	National Semi-conductor	LM302
IC4	TTL Quad 2-input, POS NAND Gate	2025-0003	TI	SN7400N
IC5	Quad 2-input, NOR Gate	2025-0019	Signetics	SP380A
IC6	Quad 2-input, NOR Gate	2025-0019	Signetics	SP380A
IC7-IC40	Not Used			
IC41	Ampl, RF	2025-0012	RCA	CA3028A
IC42	Ampl, Operational	2025-0022	TI	SN72741N
	RESISTORS			
R1	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R2	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R3	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R4	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R5	Comp, 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
R6	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R7	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R8	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R9	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley	CB5625
R10	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R11	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley	CB5625
R12	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R13	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R14	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R15	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R16	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R17	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R18	Comp, 270Ω ±5%, 2W	1069-2715	Allen-Bradley	HB2715
R19-R40	Not Used			
R41	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R42	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley	CB5625
R43	Comp, 27kΩ ±5%, 1/4W	1066-2735	Allen-Bradley	CB2735
R44	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley	CB1225
R45	Comp, 1MΩ ±5%, 1/4W	1066-1055	Allen-Bradley	CB1055
R46	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley	CB2215
R47	Met. Film, 2.21kΩ ±1%, 1/8W	1075-0010	Electra	MF5C-D-2211-F
R48	Comp, 820Ω ±5%, 1/4W	1066-8215	Allen-Bradley	CB8215
R49	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R50	Trimmer, Cer, Met 500Ω ±10%, 3/4W	1215-0011	Helitrim	89WR500
R51	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R52	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R53	Met. Film, 619Ω ±1%, 1/8W	1075-0063	Dale	MFF-1/8-T-1
R54	Comp, 75Ω ±5%, 1/4W	1066-7505	Allen-Bradley	CB7505
R55	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R56	Comp, 1 MΩ ±5%, 1/4W	1066-1055	Allen-Bradley	CB1055
R57	Comp, 1 MΩ ±5%, 1/4W	1066-1055	Allen-Bradley	CB1055

SAMPLE AND HOLD/CALIBRATION AMPLIFIER (cont). 2400

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	TRANSISTORS			
Q1	Si, PNP	1272-0023	Fairchild	2N4121
Q2	Si, NPN	1272-0016	Fairchild	2N4275
Q3	Si, FET, N-Channel	1272-0025	Amelco	2N4092
Q4	Si, PNP	1272-0023	Fairchild	2N4121
Q5	Si, NPN	1272-0016	Fairchild	2N4275
Q6	Si, FET, N-Channel	1272-0025	Amelco	2N4092
Q7	Si, PNP	1272-0023	Fairchild	2N4121
Q8	Si, NPN	1272-0016	Fairchild	2N4275
Q9	Si, NPN	1272-0014	Fairchild	2N3567





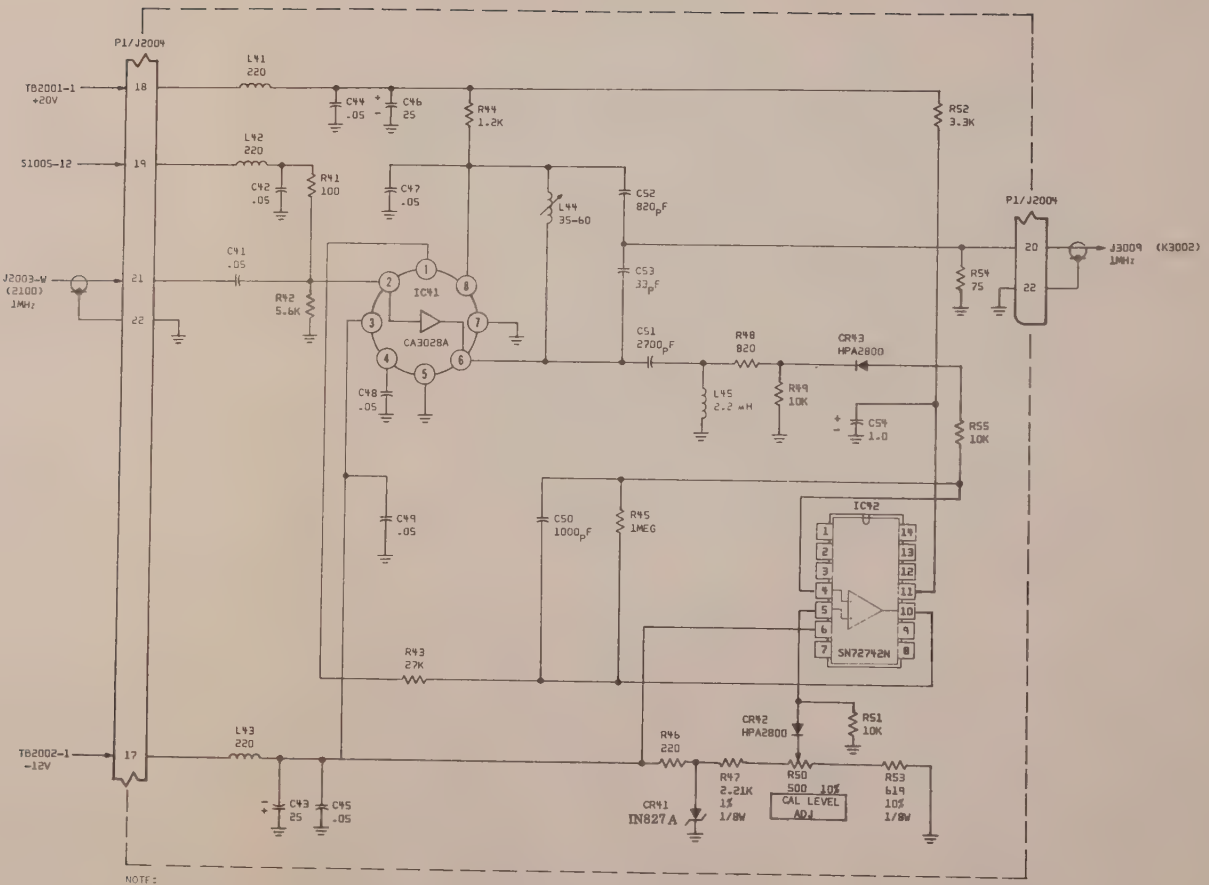
NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
6. REPLACES DWG NO 3521131 (EC-40)

IC.S NO.	TYPE	TERM. NO.	
		VCC	GND
4	SN7400N	14	7
5,6	SP380A	8	1

5601-0046

Figure 3-7. Sample and Hold/Calibration Amplifier, sheet 1. 2400



NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

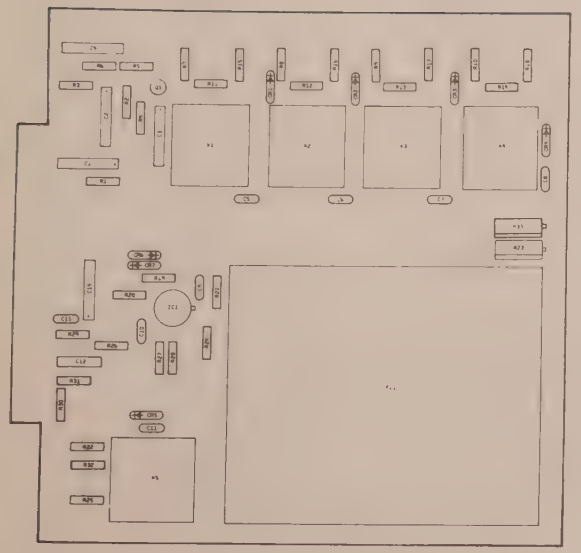
Figure 3-7. Sample and Hold/Calibration Amplifier, sheet 2. 2400

SECOND IF AMPLIFIER/200 Hz BAND PASS FILTER. 2500

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2500	Board Assy., Second IF Amplifier/ 200 Hz Bandpass Filter	7001-0192	Cushman	
	Board, Printed Circuit	1780-0123	Cushman	
	CAPACITORS			
C1	Elect., 100 μF ±10%, 25V	1013-0003	Sprague	30D-107G025DD2
C2	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C3	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C4	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C5	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C6	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C7	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C8	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C9	Mica, 510 pF ±5%, 500V	1002-0036	Elmenco	DM15-F-511J
C10	Mica, 22 pF ±5%, 500V	1002-0023	Elmenco	DM15-C-220J
C11	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C12	Poly, 0.1 μF ±10%, 100V	1008-0031	Sprague	225P10491WA3
C13	Not Used			
C14	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C15	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
	DIODES			
CR1	Si, High Speed	1281-0013	Transitron	1N3064
CR2	Si, High Speed	1281-0013	Transitron	1N3064
CR3	Si, High Speed	1281-0013	Transitron	1N3064
CR4	Si, High Speed	1281-0013	Transitron	1N3064
CR5	Si, High Speed	1281-0013	Transitron	1N3064
CR6	Si, High Speed	1281-0013	Transitron	1N3064
CR7	Si, High Speed	1281-0013	Transitron	1N3064
	FILTER			
FL1	Crystal, 80 kHz	1040-0014	Cushman	
	INTEGRATED CIRCUIT			
IC1	Ampl, Operational	2025-0014	TI	SN72709L
	RELAYS			
K1	DPDT, 12VDC	1313-0002	Pot. Brumfield	R102E-Z2-V185
K2	DPDT, 12VDC	1313-0002	Pot. Brumfield	R102E-Z2-V185
K3	DPDT, 12VDC	1313-0002	Pot. Brumfield	R102E-Z2-V185
K4	DPDT, 12VDC	1313-0002	Pot. Brumfield	R102E-Z2-V185
K5	DPDT, 12VDC	1313-0002	Pot. Brumfield	R102E-Z2-V185
	RESISTORS			
R1	Comp, 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R2	Comp, 12kΩ ±5%, 1/4W	1066-1235	Allen-Bradley	CB1235
R3	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R4	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R5	Comp, 82Ω ±5%, 1/4W	1066-8205	Allen-Bradley	CB8205
R6	Comp, 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R7	Met. Film, 733.2Ω ±0.25%, 0.1 W	1074-0084	Dale	MF-1/10-T-9
R8	Met. Film, 4.799kΩ ±0.25%, 0.1 W	1074-0032	Dale	MF-1/10-T-9
R9	Met. Film, 4.113kΩ ±0.25%, 0.1 W	1074-0030	Dale	MF-1/10-T-9
R10	Met. Film, 1.26k ±0.25%, 0.1W1 W	1074-0095	Dale	MF-1/10-T-9
R11	Met. Film. 2.970kΩ ±0.25%, 0.1 W	1074-0085	Dale	MF-1/10-T-9
R12	Met. Film, 152.4Ω ±0.25%, 0.1 W	1074-0018	Dale	MF-1/10-T-9
R13	Met. Film, 178.9Ω ±0.25%, 0.1 W	1074-0020	Dale	MF-1/10-T-9

SECOND IF AMPLIFIER/200 Hz BAND PASS FILTER (cont). 2500

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R14	Met. Film, 739.1Ω ±.25%, 0.1W	1074-0093	Dale	MF-1/10-T-9
R15	Met. Film, 733.2Ω ±0.25%, 0.1 W	1074-0084	Dale	MF-1/10-T-9
R16	Met. Film, 4.799kΩ ±0.25%, 0.1 W	1074-0032	Dale	MF-1/10-T-9
R17	Met. Film, 4.113kΩ ±0.25%, 0.1 W	1074-0030	Dale	MF-1/10-T-9
R18	Met. Film, 1.26k ±0.25%, 0.1W1 W	1074-0095	Dale	MF-1/10-T-9
R19	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R20	Met. Film, 600Ω ±0.5%, 0.1W	1074-0023	Dale	MF-1/10-T-9
R21	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R22	Comp, 12kΩ ±5%, 1/4W	1066-1235	Allen-Bradley	CB1235
R23	Trimmer, Cer, Met., 100Ω ±10% 3/4W	1215-0010	Helitrim	89WR100
R24	Comp, 910Ω, ±5%, 1/4W	1066-9115	Allen-Bradley	CB 9115
R25	Comp, 12kΩ ±5%, 1/4W	1066-1235	Allen-Bradley	CB1235
R26	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R27	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R28	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R29	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R30	Met. Film, 1.82kΩ ±1%, 1/8W	1075-0065	Dale	MFF-1/8-T-1
R31	Met. Film, 453Ω ±1%, 1/8W	1075-0107	Dale	MFF-1/8-T-1
R32	Met. Film, 1.82kΩ ±1%, 1/8W	1075-0065	Dale	MFF-1/8-T-1
R33	Trimmer, Cer. Pot, 10k, ±10%, 3/4W	1215-0014	Helitrim	89 WR10K
	TRANSISTOR			
Q1	Si, NPN	1272-0022	Fairchild	2N3563



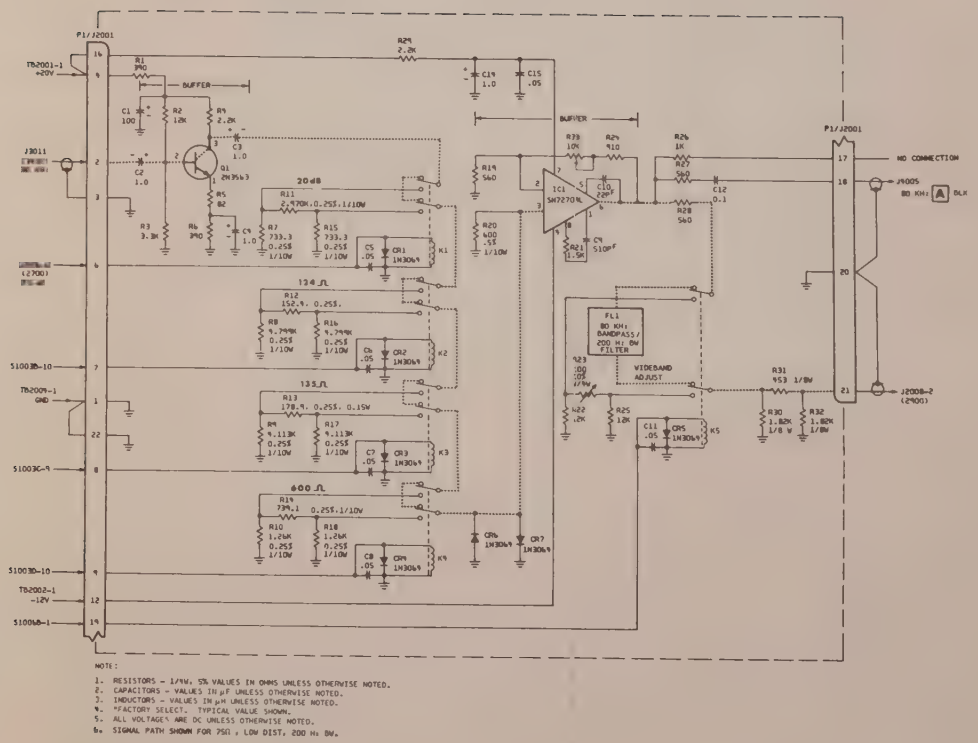
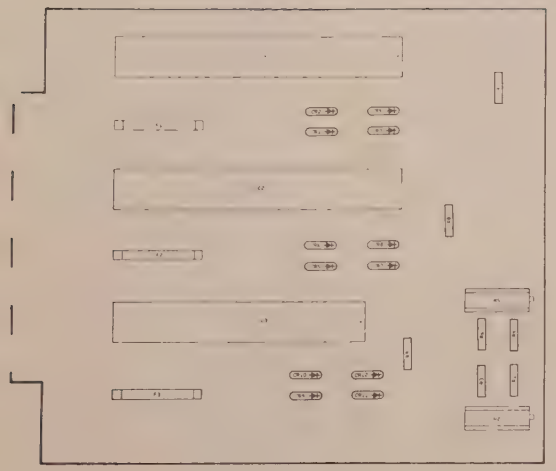
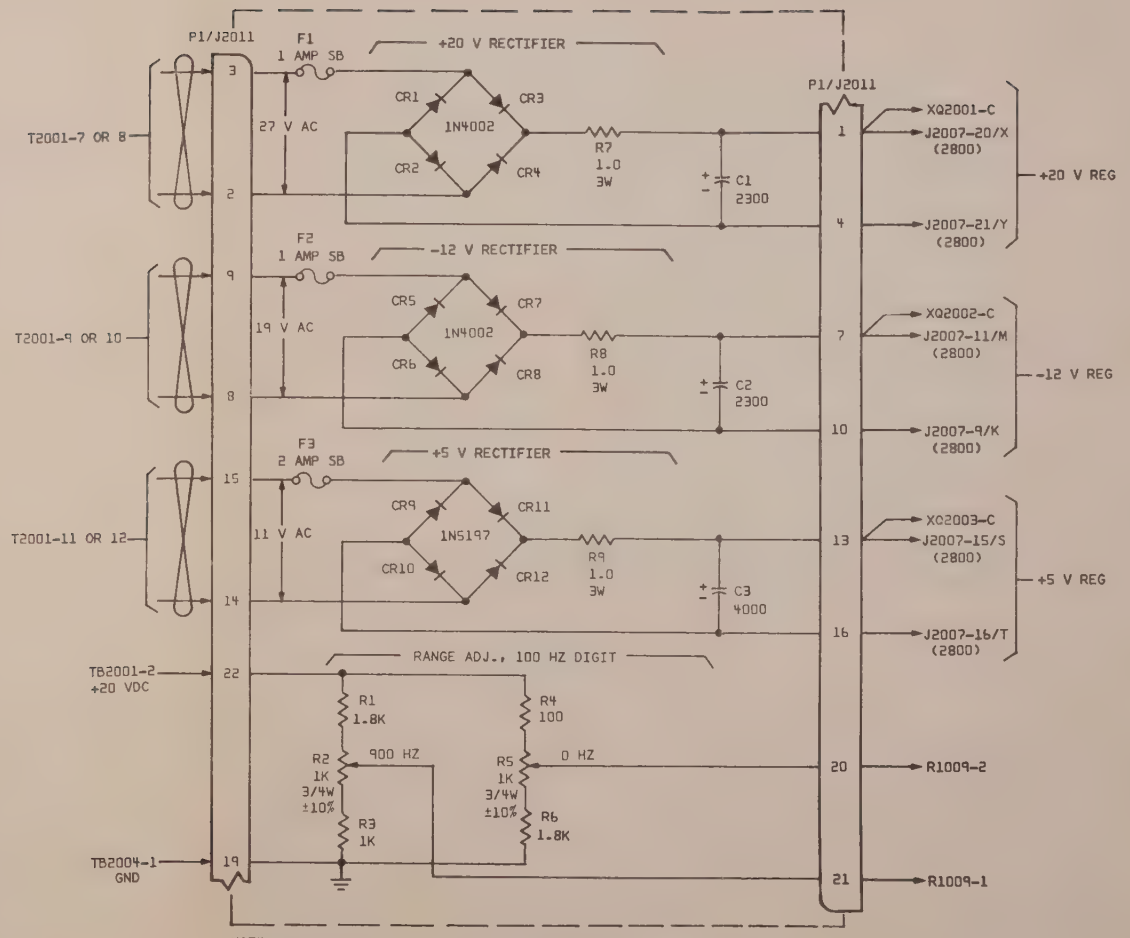


Figure 3-8. Second IF Amplifier/200 Hz Band Pass Filter. 2500

POWER SUPPLY RECTIFIERS. 2600

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2600	Board Assy., Power Supply Rectifier	7001-0057	Cushman	
	Board, Printed Circuit	1780-0124	Cushman	
	CAPACITORS			
C1	Elect., 2300 μF +75 -10%, 50V	1014-0004	Sprague	39D-238G050JT4
C2	Elect., 2300 μF +75 -10%, 50V	1014-0004	Sprague	39D-238G050JT4
C3	Elect., 4000 μF +75 -10%, 25V	1014-0005	Sprague	39D-408G025JS4
	DIODES			
CR1	100V, PIV	1281-0023	ITT	1N4002
CR2	100V, PIV	1281-0023	ITT	1N4002
CR3	100V, PIV	1281-0023	ITT	1N4002
CR4	100V, PIV	1281-0023	ITT	1N4002
CR5	100V, PIV	1281-0023	ITT	1N4002
CR6	100V, PIV	1281-0023	ITT	1N4002
CR7	100V, PIV	1281-0023	ITT	1N4002
CR8	100V, PIV	1281-0023	ITT	1N4002
CR9	2 Amp, 50V, Rectifier	1281-0024	Semtech	1N5197
CR10	2 Amp, 50V, Rectifier	1281-0024	Semtech	1N5197
CR11	2 Amp, 50V, Rectifier	1281-0024	Semtech	1N5197
CR12	2 Amp, 50V, Rectifier	1281-0024	Semtech	1N5197
	FUSES			
F1	Slo-Blo, 1 Amp	1955-0006	Littelfuse	313001
F2	Slo-Blo, 1 Amp	1955-0006	Littelfuse	313001
F3	Slo-Blo, 2 Amp	1955-0001	Littelfuse	313002
	RESISTORS			
R1	Comp, 1.8kΩ ±5%, 1/4W	1066-1825	Allen-Bradley	CB1825
R2	Trimmer, Cer, Met.,1kΩ ±10%, 3/4W	1215-0013	Helitrim	89WR1K
R3	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R4	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R5	Trimmer, Cer, Met., 1kΩ ±10%, 3/4W	1215-0013	Helitrim	89WR1K
R6	Comp, 1.8kΩ ±5%, 1/4W	1066-1825	Allen-Bradley	CB1825
R7	WW, 1Ω ±5%, 3W	1159-0001	Ohmite	4330
R8	WW, 1Ω ±5%, 3W	1159-0001	Ohmite	4330
R9	WW, 1Ω ±5%, 3W	1159-0001	Ohmite	4330





NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 3-9. Power Supply Rectifiers. 2600

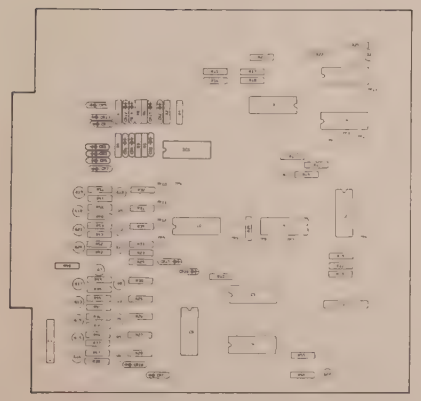
ATTENUATOR CONTROL LOGIC. 2700

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2700	Board Assy., Attenuator Control Logic	7001-0058	Cushman	
	Board, Printed Circuit	1780-0126	Cushman	
	CAPACITORS			
C1	Elect., 100 μF ±10%, 25V	1013-0003	Sprague	30D-107G025DD2
C2	Elect., 100 μF +75 -10%, 12V	1013-0011	Sprague	30D-107G012CC2
	DIODES			
CR1	Ge, Signal	1282-0005	ITT	G633
CR2	Ge, Signal	1282-0005	ITT	G633
CR3	Ge, Signal	1282-0005	ITT	G633
CR4	Ge, Signal	1282-0005	ITT	G633
CR5	Ge, Signal	1282-0005	ITT	G633
CR6	Ge, Signal	1282-0005	ITT	G633
CR7	Ge, Signal	1282-0005	ITT	G633
CR8	Ge, Signal	1282-0005	ITT	G633
CR9	Ge, Signal	1282-0005	ITT	G633
CR10	Ge, Signal	1282-0005	ITT	G633
CR11	Ge, Signal	1282-0005	ITT	G633
CR12	Ge, Signal	1282-0005	ITT	G633
CR13	Ge, Signal	1282-0005	ITT	G633
CR14	Ge, Signal	1282-0005	ITT	G633
CR15	Ge, Signal	1282-0005	ITT	G633
CR16	Ge, Signal	1282-0005	ITT	G633
CR17	Si, High Speed	1281-0013	Transitron	1N3064
CR18	Si, High Speed	1281-0013	Transitron	1N3064
	INTEGRATED CIRCUITS			
IC1	4 Bit, Full Adder	2025-0021	TI	SN7483N
IC2	4 Bit, Full Adder	2025-0021	TI	SN7483N
IC3	Quad 2-input NOR Gate	2025-0019	Signetics	SP380A
IC4	Quad 2-input NOR Gate	2025-0019	Signetics	SP380A
IC5	TTL Quad 2-input, POS NAND Gate	2025-0003	TI	SN7400N
IC6	Dual AND-OR invert. gate	2025-0018	Signetics	N8840A
IC7	Dual AND-OR invert. gate	2025-0018	Signetics	N8840A
IC8	4 Bit, Full Adder	2025-0021	TI	SN7483N
IC9	4 Bit, Full Adder	2025-0021	TI	SN7483N
IC10	Quad 2-input NOR Gate	2025-0019	Signetics	SP380A
	RESISTORS			
R1	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R2	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R3	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R4	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R5	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R6	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R7	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R8	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R9	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R10	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R11	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R12	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R13	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R14	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R15	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R16	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R17	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R18	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R19	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R20	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R21	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R22	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R23	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R24	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R25	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R26	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R27	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R28	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R29	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R30	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R31	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R32	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R33	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R34	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R35	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R36	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R37	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R38	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R39	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R40	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R41	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R42	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R43	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R44	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R45	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R46	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R47	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R48	Comp, 270Ω ±5%, 2W	1069-2715	Allen-Bradley	HB2715
R49	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R50	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R51	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R52	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R53	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R54	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R55	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
	TRANSISTORS			
Q1	Si, NPN	1272-0016	Fairchild	2N4275
Q2	Si, NPN	1272-0016	Fairchild	2N4275
Q3	Si, PNP	1272-0023	Fairchild	2N4121
Q4	Si, PNP	1272-0023	Fairchild	2N4121
Q5	Si, PNP	1272-0023	Fairchild	2N4121
Q6	Si, PNP	1272-0023	Fairchild	2N4121
Q7	Si, NPN	1272-0014	Fairchild	2N3567
Q8	Si, PNP	1272-0023	Fairchild	2N4121
Q9	Si, PNP	1272-0023	Fairchild	2N4121
Q10	Si, PNP	1272-0023	Fairchild	2N4121
Q11	Si, PNP	1272-0023	Fairchild	2N4121
Q12	Si, PNP	1272-0023	Fairchild	2N4121
Q13	Si, NPN	1272-0016	Fairchild	2N4275
Q14	Si, NPN	1272-0016	Fairchild	2N4275
Q15	Si, NPN	1272-0016	Fairchild	2N4275

ATTENUATOR CONTROL LOGIC (cont). 2700

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
Q16	Si, NPN	1272-0016	Fairchild	2N4275
Q17	Si, NPN	1272-0016	Fairchild	2N4275
Q18	Si, NPN	1272-0016	Fairchild	2N4275
Q19	Si, NPN	1272-0016	Fairchild	2N4275
Q20	Si, NPN	1272-0016	Fairchild	2N4275
Q21	Si, NPN	1272-0016	Fairchild	2N4275
Q22	Si, NPN	1272-0016	Fairchild	2N4275



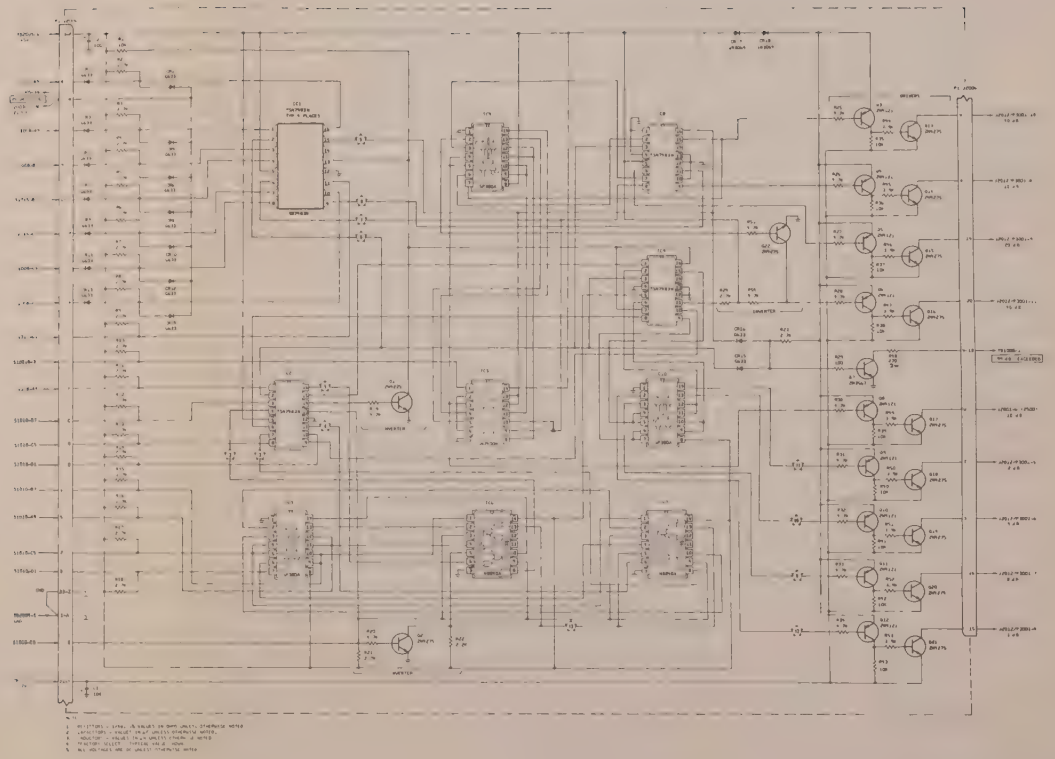


Figure 3-10. Attenuator Control Logic. 2700

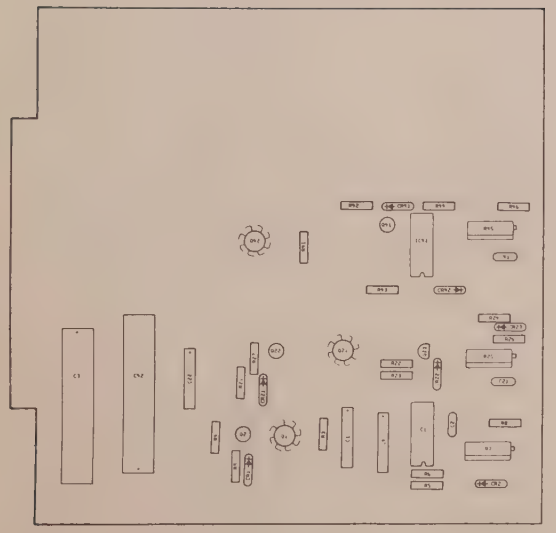
5691-0046

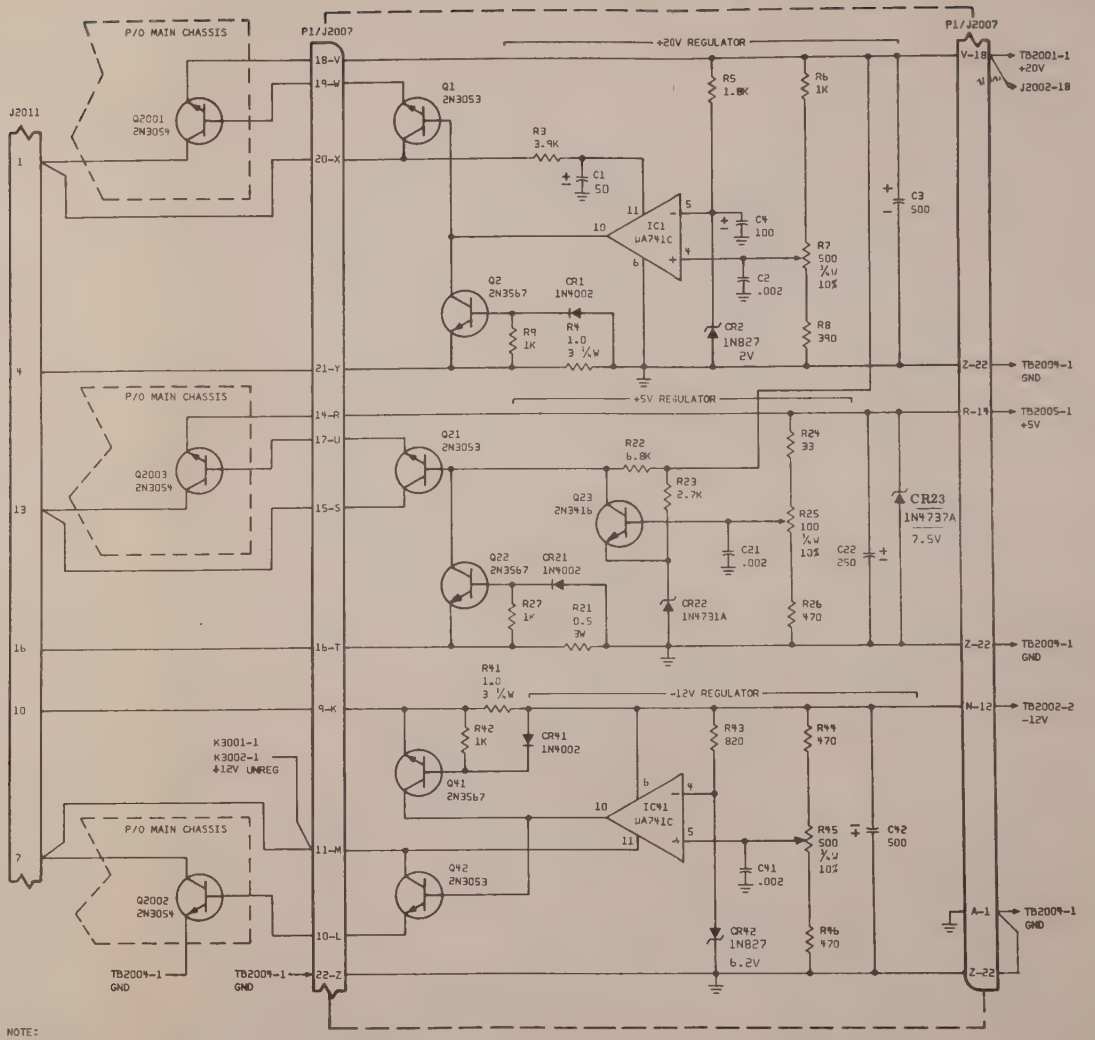
POWER SUPPLY REGULATORS, 2800

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2800	Board Assy., Power Supply Regs.	7001-0059	Cushman	
	Board, Printed Circuit	1780-0128	Cushman	
	CAPACITORS			
C1	Elect., 50 μf +75 -10%, 50 V	1013-0007	Sprague	30D506G050DD5
C2	Cer, 0.002 μF ±20%, 500V	1005-0003	Erie	831060Z5U00202M
C3	Elect., 500 μF +75% -20%, 25V	1014-0002	Richey	JA-13-500-25-8-P
C4	Elect., 100 μF +75 -10%, 12V	1013-0011	Sprague	30D-107G012CC2
C5-C20	Not Used			
C21	Cer, 0.002 μF ±20%, 500V	1005-0003	Erie	831060Z5U00202M
C22	Elect., 250 μF, 16V	1013-0016	Sprague	30D-257G016DF2
C23-C40	Not Used			
C41	Cer, 0.002 μF ±20%, 500V	1005-0003	Erie	831060Z5U00202M
C42	Elect., 500 μF +75% -10%, 25V	1014-0002	Richey	JA-13-500-25-8-P
	DIODES			
CR1	Si, 100V PIV,	1281-0023	ITT	1N4002
CR2	Si, Zener, 6.2V ±5%	1281-0038	Transitron	IN827
CR3-CR20	Not Used			
CR21	Si, 100V PIV,	1281-0023	ITT	1N4002
CR22	Si, Zener, 4.3V ±5%	1281-0025	I.R.	1N4731A
CR23	Si, Zener, 7.5V ±10%	1281-0026	I.R.	1N4737A
CR24-CR40	Not Used			
CR41	Si, 100V PIV,	1281-0023	ITT	1N4002
CR42	Si, Zener, 6.2V ±5%	1281-0038	Transitron	IN827
	INTEGRATED CIRCUITS			
IC1	Ampl, Operational	2025-0022	TI	72741N
IC2-IC40	Not Used			
IC41	Ampl, Operational	2025-0022	TI	72741N
	RESISTORS			
R1-R2	Not Used			
R3	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R4	WW, 1Ω ±5%, 3W	1159-0001	Ohmite	4330
R5	Comp, 1.8kΩ ±5%, 1/4W	1066-1825	Allen-Bradley	CB1825
R6	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R7	Trimmer, Cer, Met., 500Ω ±10%, 3/4W	1215-0011	Helitrim	89WR500
R8	Comp, 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R9	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R10-R20	Not Used			
R21	WW, 0.5Ω ±3%, 3W	1159-0002	Dale	RS-2B
R22	Comp, 6.8kΩ ±5%, 1/4W	1066-6825	Allen-Bradley	CB6825
R23	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R24	Comp, 33Ω ±5%, 1/4W	1066-3305	Allen-Bradley	CB3305
R25	Trimmer, Cer, Met., 100Ω ±10%, 3/4W	1215-0010	Helitrim	89WR100
R26	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R27	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R28-R40	Not Used			
R41	WW, 1Ω ±5%, 3W	1159-0001	Ohmite	4330
R42	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R43	Comp, 820Ω ±5%, 1/4W	1066-8215	Allen-Bradley	CB8215
R44	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R45	Trimmer, Cer, Met., 500Ω ±10%, 3/4W	1215-0011	Helitrim	89WR500

POWER SUPPLY REGULATORS (cont). 2800

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R46	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
	TRANSISTORS			
Q1	Si, NPN	1272-0011	RCA	2N3053
Q2	Si, NPN	1272-0014	Fairchild	2N3567
Q3-Q20	Not Used			
Q21	Si, NPN	1272-0011	RCA	2N3053
Q22	Si, NPN	1272-0014	Fairchild	2N3567
Q23	Si, NPN	1271-0006	GE	2N3416
Q24-Q40	Not Used			
Q41	Si, NPN	1272-0014	Fairchild	2N3567
Q42	Si, NPN	1272-0011	RCA	2N3053





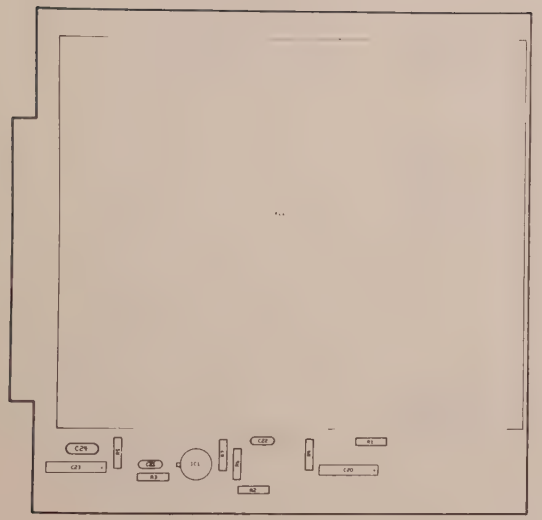
NOTE:

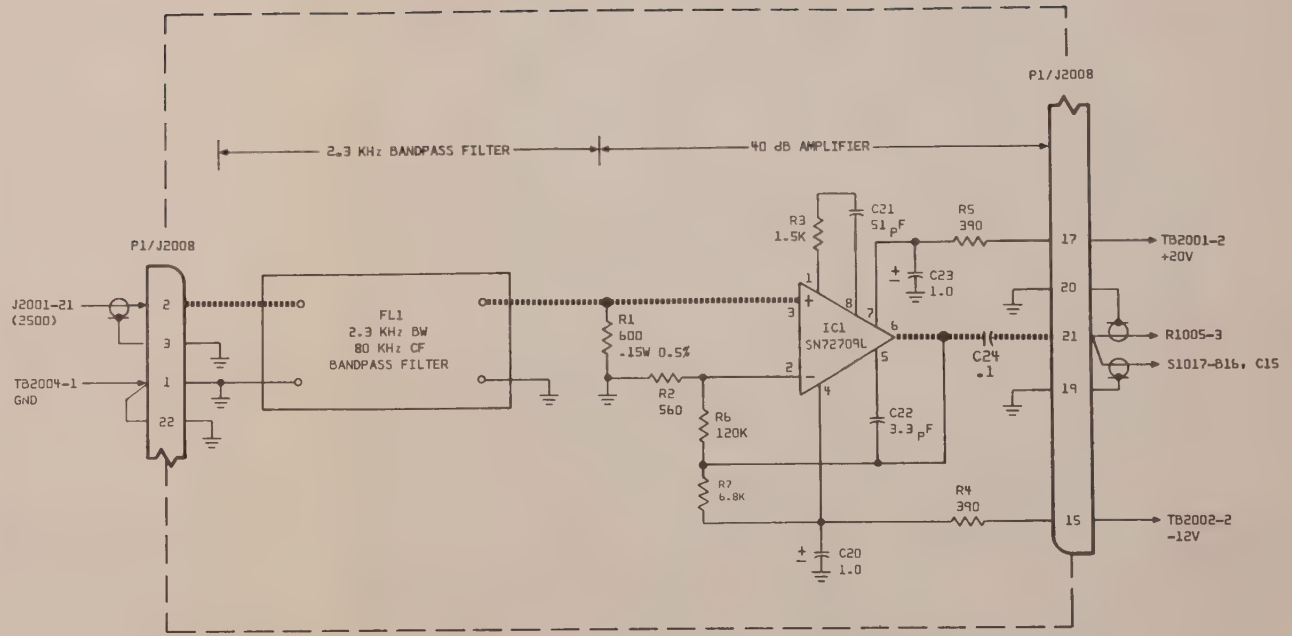
1. RESISTORS – 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS – VALUES IN µF UNLESS OTHERWISE NOTED.
3. INDUCTORS – VALUES IN µH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 3-11. Power Supply Regulators. 2800

SECOND IF AMPLIFIER/2.3 kHz BAND PASS FILTER. 2900

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
2900	Board Assy., Second IF Amplifier/ 2.3 kHz Bandpass Filter	7001-0060	Cushman	
	Board, Printed Circuit	1780-0130	Cushman	
	CAPACITORS			
C1-C19	Not Used			
C20	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C21	Mica, 51 pF ±5%, 500V	1002-0045	Elmenco	DM15-E-510J
C22	Cer, 3.3 pF ±0.25 pF, 500V	1005-0011	Erie	301-000-C0J0-339C
C23	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C24	Cer., .1 μf ±10%, 100V	1005-0064	Aerovox	CK06BX104K
	FILTER			
FL1	Crystal, 80 kHz	1040-0020	Cushman	
	INTEGRATED CIRCUIT			
IC1	Ampl, Operational	2025-0014	TI	SN72709L
	RESISTORS			
R1	Met. Film, 600Ω ±0.5%, 0.1 W	1074-0023	Dale	MF-1/10-T-9
R2	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R3	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R4	Comp, 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R5	Comp, 390Ω ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R6	Comp, 120kΩ ±5%, 1/4W	1066-1245	Allen-Bradley	CB1245
R7	Comp, 6.8kΩ, ±5%, 1/4W	1066-6825	Allen-Bradley	CB 6825





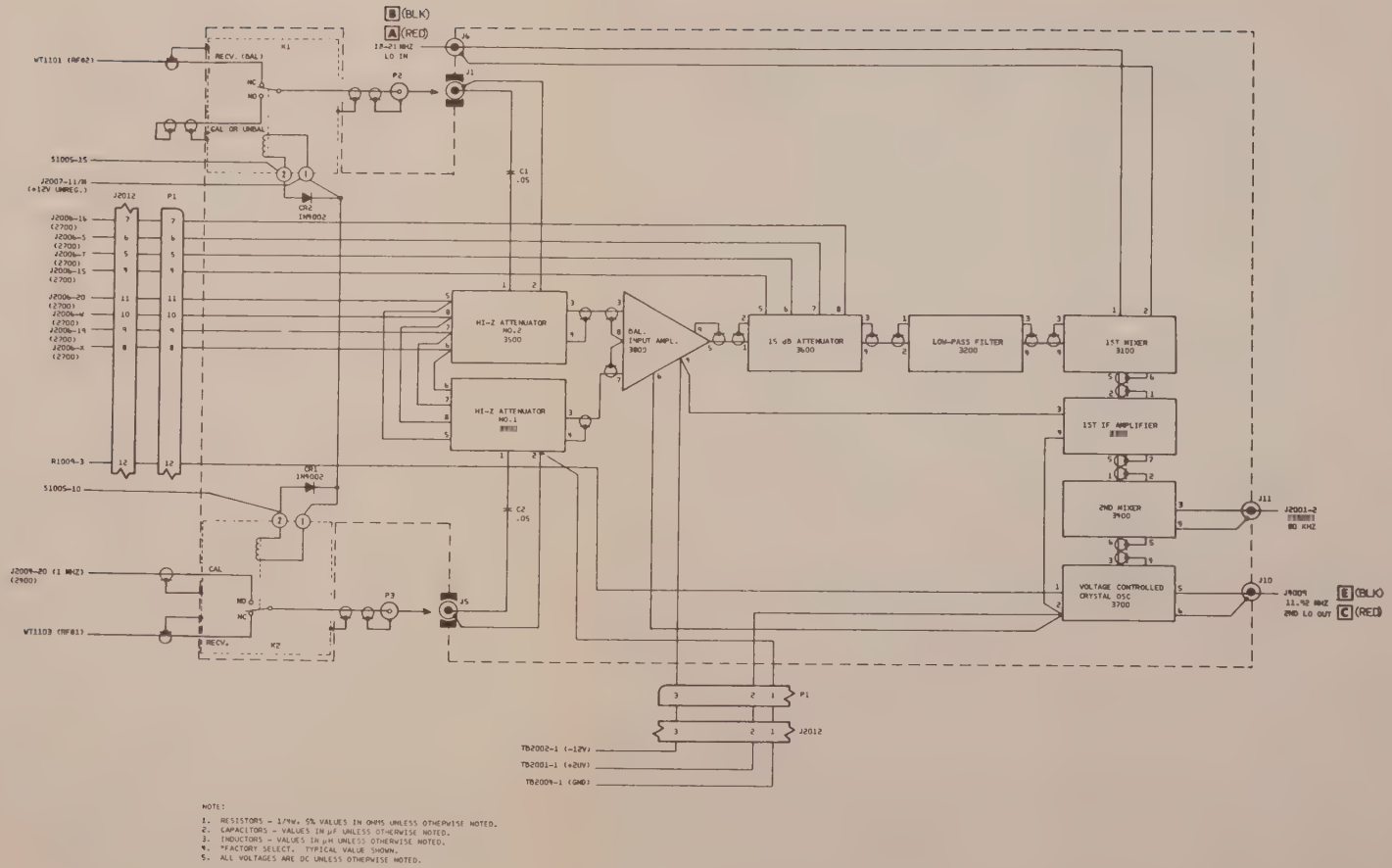
NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 3-12. Second IF Amplifier/2.3 kHz Band Pass Filter. 2900

RF CASTING. 3000

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3000	RF Housing Assembly	7046-0008	Cushman	
	RF Casting	4560-0007	Cushman	
	RF Housing Assembly, Top Cover	2180-0036	Cushman	
	RF Housing Assembly, Bottom Cover	2180-0037	Cushman	
	PRINTED CIRCUIT BOARDS			
3100	First Mixer Board Assy.	7001-0061	Cushman	
3200	Low-Pass Filter Board Assy.	7001-0062	Cushman	
3300	First IF Amplifier Board Assy.	7001-0063	Cushman	
3400	Second IF Amplifier Board Assy.	7001-0064	Cushman	
3500	Hi-Z Attenuator No. 2 Board Assy.	7001-0065	Cushman	
3600	15 dB Attenuator Board Assy.	7001-0067	Cushman	
3700	Voltage Controlled Crystal Osc. Board Assy.	7001-0068	Cushman	
3800	Balanced Input Amplifier Bd Assy.	7001-0069	Cushman	
3900	Hi-Z Attenuator No. 1 Bd Assy.	7001-0138	Cushman	
	CAPACITORS			
C1	Cer, 0.05 μF +80% -20%, 500V	1005-0052	Sprague	5HK-S50
C2	Cer, 0.05 μF +80% -20%, 500V	1005-0052	Sprague	5HK-S50
	DIODE			
CR1	Si, 100V PIV	1281-0023	ITT	IN4002
CR2	Si, 100V PIV	1281-0023	ITT	IN4002
	JACKS			
J1	Connector, Rt. Angle	2536-0006	Startronics	UG-1098/U
J2	Not Used			
J3	Not Used			
J4	Not Used			
J5	Connector, Rt. Angle	2536-0006	Startronics	UG-1098/U
J6	Connector, Rt. Angle	2536-0006	Startronics	UG-1098/U
J7	Not Used			
J8	Not Used			
J9	Not Used			
J10	Connector, Rt. Angle	2536-0006	Startronics	UG-1098/U
J11	Connector, Rt. Angle	2536-0006	Startronics	UG-1098/U
J12	Connector, Rt. Angle	2536-0006	Startronics	UG-1098/U
	PLUGS			
K1P2	Connector, BNC	2536-0002	Kings	KC59-167CR
K2P3	Connector, BNC	2536-0002	Kings	KC59-167CR
	RELAYS			
K1	Coaxial, 50Ω, 250W, 28V	1313-0010	Magnecraft	120X-15
K2	Coaxial, 50Ω, 250W, 28V	1313-0010	Magnecraft	120X-15



NOTE:

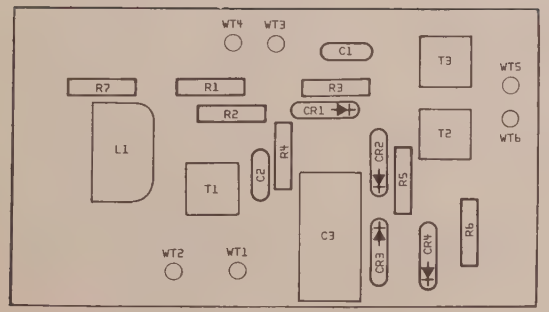
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

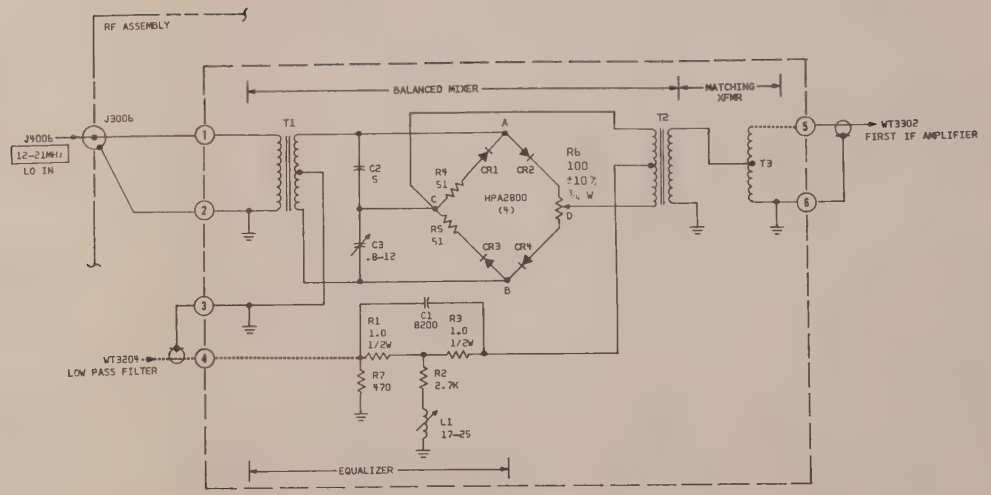
Figure 3-13. Interconnection Diagram, RF Casting. 3000

5601**0046

FIRST MIXER, 3100

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3100	Board Assy., First Mixer	7001-0061	Cushman	
	Board, Printed Circuit	1780-0115	Cushman	
	CAPACITORS			
C1	Mica, 8200 pF ±5%, 100V	1002-0076	Elmenco	DM19-822J
C2	Mica, 5 pF ±5%, 500V	1002-0028	Elmenco	DM15-C-050D
C3	Var, Glass, 0.8 - 12 pF, 750V	1001-0007	JFD	VC31GWY
	DIODES			
CR1	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
CR2	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
CR3	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
CR4	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
	INDUCTOR			
L1	Var, 17 - 25 μH	1596-0005	Cushman	
	RESISTORS			
R1	Comp, 1Ω ±5%, 1/2W	1067-0001	Allen-Bradley	EB0001
R2	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R3	Comp, 1Ω ±5%, 1/2W	1067-0001	Allen-Bradley	EB0001
R4	Comp, 51Ω ±5%, 1/4W	1066-5105	Allen-Bradley	CB5105
R5	Comp, 51Ω ±5%, 1/4W	1066-5105	Allen-Bradley	CB5105
R6	Trimmer, Cer, Met., 100Ω ±10%, 3/4W	1215-0009	Beckman	89PR100
R7	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
	TRANSFORMERS			
T1	Toroid, Tri-Filar	1579-0017	Cushman	
T2	Toroid, Tri-Filar	1579-0017	Cushman	
T3	Toroid, Tri-Filar	1579-0017	Cushman	





NOTE:

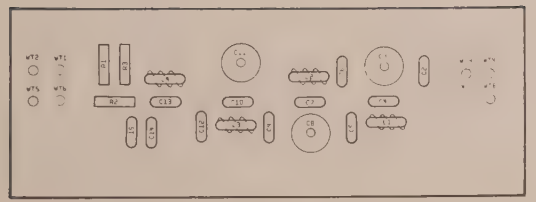
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN pF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN µH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

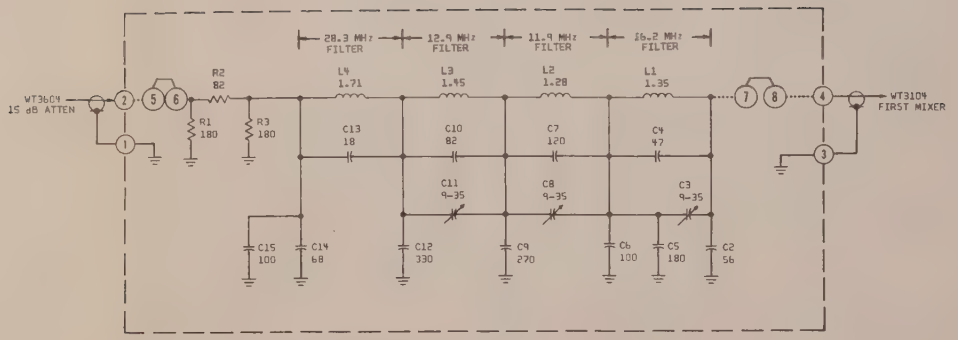
Figure 3-14. First Mixer. 3100

5601-0046

LOW PASS FILTER. 3200

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3200	Board Assy., Low Pass Filter	7001-0062	Cushman	
	Board, Printed Circuit	1780-0116	Cushman	
	CAPACITORS			
C1	Not Used			
C2	Mica, 56 pF ±5%, 500V	1002-0019	Elmenco	DM15-E-560J
C3	Trimmer, Cer, 9-35 pF, 350V	1001-0006	Erie	538-002-94D
C4	Mica, 47 pF ±5%, 500V	1002-0012	Elmenco	DM15-E-470J
C5	Mica, 180 pF ±5%, 500V	1002-0005	Elmenco	DM15-F-181J
C6	Mica, 100 pF ±5%, 500V	1002-0011	Elmenco	DM15-F-101J
C7	Mica, 120 pF ±5%, 500V	1002-0010	Elmenco	DM15-F-121J
C8	Trimmer, Cer, 9-35 pF, 350V	1001-0006	Erie	538-002-94D
C9	Mica, 270 pF ±5%, 500V	1002-0031	Elmenco	DM15-F-271J
C10	Mica, 82 pF 5%, 500V	1002-0020	Elmenco	DM15-E-820J
C11	Trimmer, Cer, 9-35 pF, 350V	1001-0006	Erie	538-002-94D
C12	Mica, 330 pF ±5%, 500V	1002-0032	Elmenco	DM15-F-331J
C13	Mica, 18 pF ±5%, 500V	1002-0014	Elmenco	DM15-C-180J
C14	Mica, 68 pF ±5%, 500V	1002-0013	Elmenco	DM15-E-680J
C15	Mica, 100 pF ±5%, 500V	1002-0011	Elmenco	DM15-F-101J
	INDUCTORS			
L1	Toroid, 1.35 μH	1579-0020-02	Cushman	
L2	Toroid, 1.28 μH	1579-0020-01	Cushman	
L3	Toroid, 1.45 μH	1579-0020-03	Cushman	
L4	Toroid, 1.71 μH	1579-0020-04	Cushman	
	RESISTORS			
R1	Comp, 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815
R2	Comp, 82Ω ±5%, 1/4W	1066-8205	Allen-Bradley	CB8205
R3	Comp, 180Ω ±5%, 1/4W	1066-1815	Allen-Bradley	CB1815





NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN pF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN µH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 3-15. Low Pass Filter. 3200

5681-8046

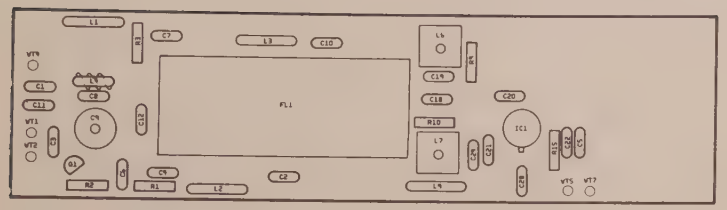
FIRST IF AMPLIFIER. 3300

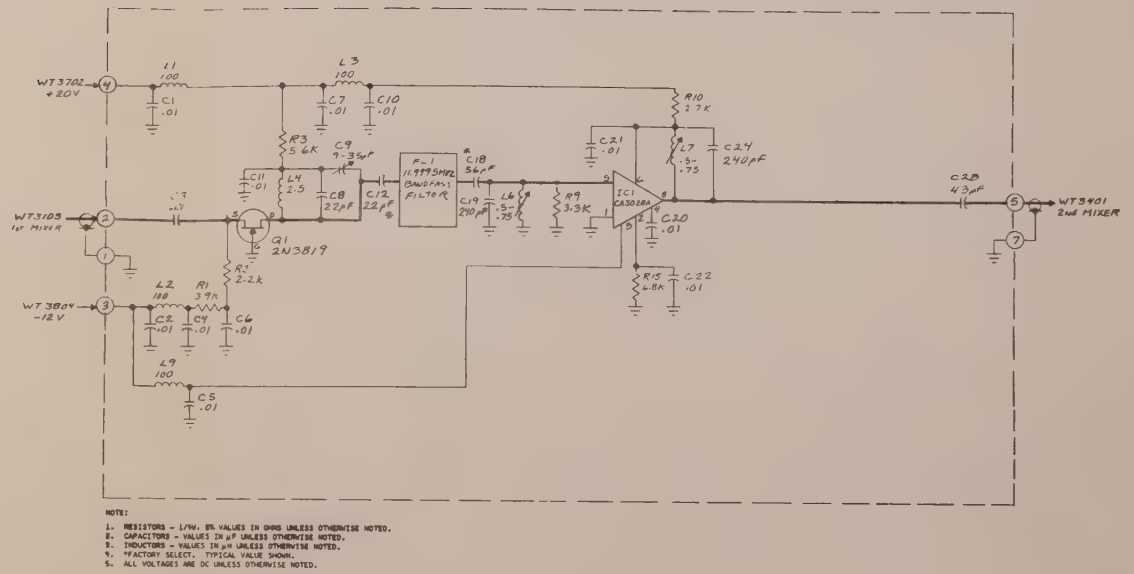
CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3300	Board Assy., First IF Amplifier	7001-0191	Cushman	
	Board, Printed Circuit	1780-0117	Cushman	
	CAPACITORS			
C1	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C2	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C3	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C4	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C5	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C6	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C7	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C8	Mica, 22 pF ±5%, 500V	1002-0023	Elmenco	DM15-C-220J
C9	Trimmer, Cer, 9-35 pF, 350V, N650	1001-0006	Erie	538-002-94D
C10	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C11	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
*C12	Mica, 22 pF ±5%, 500V	1002-0023	Elmenco	DM15-C-220J
C13	Not used			
C14	Not used			
C15	Not used			
C16	Not used			
C17	Not used			
*C18	Mica, 56 pF ±5%, 500V	1002-0019	Elmenco	DM15-E-560J
C19	Mica, 240 pF ±5%, 500V	1002-0030	Elmenco	DM15-F-241J
C20	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C21	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C22	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C23	Not used			
C24	Mica, 240 pF ±5%, 500V	1002-0030	Elmenco	DM15-F-241J
C25	Not used			DM15-F-241J
C26	Not used			
C27	Not used			
C28	Mica, 43 pF ±5%, 500V	1002-0046	Elmenco	DM15-E-430J
C29	Not used			
C30	Not used			
	FILTER			
FL1	Crystal, 11.9995 MHz	1040-0017	Cushman	
	INDUCTORS			
L1	Choke, 100 μH ±5%	1585-0017	Delevan	1537-76
L2	Choke, 100 μH ±5%	1585-0017	Delevan	1537-76
L3	Choke, 100 μH ±5%	1585-0017	Delevan	1537-76
L4	Toroid, 2.5 μH	1579-0019	Cushman	
L5	Not used			
L6	Var, 0.50 - 0.75 μH	1596-0011	Cushman	
L7	Var. 0.50 - 0.75 μH	1596-0011	Cushman	
L8	Not used			
L9	Choke, 100 μH ±5%	1585-0017	Delevan	1537-76
L10	Not used	1585-0017	Delevan	1537-76
	INTEGRATED CIRCUIT			
IC1	Ampl, RF	2025-0012	RCA	CA3028A
	RESISTORS			
R1	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R2	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R3	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley	CB5625

* Factory selected. Typical value given.

FIRST IF AMPLIFIER (cont). 3300

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R4	Not used			
R5	Not used			
R6	Not used			
R7	Not used			
R8	Not used			
R9	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R10	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R11	Not used			
R12	Not used			
R13	Not used			
R14	Not used			
R15	Comp, 6.8kΩ ±5%, 1/4W	1066-6825	Allen-Bradley	CB6825
	TRANSISTORS			
Q1	Si, FET, N-Channel	1272-0039	TI	2N3819
Q2	Not used			
Q3	Not used			





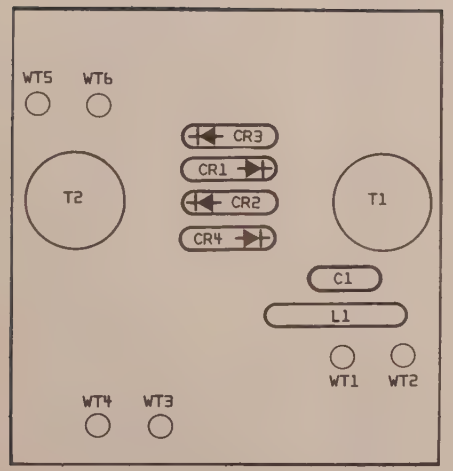
NOTE:

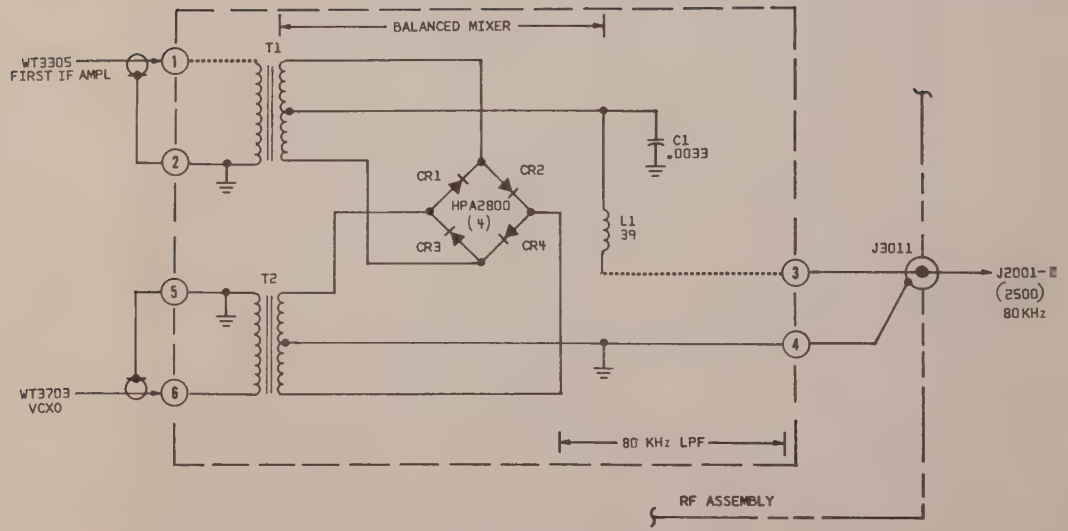
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 3-16. First IF Amplifier, 3300

SECOND MIXER. 3400

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3400	Board Assembly, Second Mixer	7001-0064	Cushman	
	Board, Printed Circuit	1780-0119	Cushman	
	CAPACITOR			
C1	Poly, 0.0033 μF ±10%, 100V	1008-0041	Sprague	225P33291WA3
	DIODES			
CR1	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
CR2	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
CR3	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
CR4	Si, Hot Carrier	1283-0001	HPA	H-P 5082-2800
	INDUCTOR			
L1	Choke, RF, 39 μH ±5%	1585-0043	Delevan	1537-56
	TRANSFORMERS			
T1	Toroid, Tri-filar	1579-0017	Cushman	
T2	Toroid, Tri-filar	1579-0017	Cushman	





NOTE:

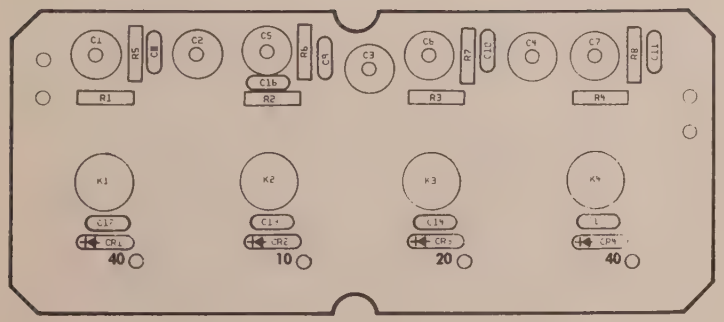
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 3-17. Second Mixer. 3400

HI-Z ATTENUATOR No. 2. 3500

3500

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3500	Board Assy., Hi-Z Attenuator, No.2	7001-0065	Cushman	
	Board, Printed Circuit	1780-0120	Cushman	
	CAPACITORS			
C1	Trimmer, Cer, 2-8 pF, 350V	1001-0004	Erie	538-002A-2-8-89A
C2	Trimmer, Air, Var, 1.9-15.7 pF	1000-0007	E. F. Johnson	187-109-5
C3	Trimmer, Air, Var, 1.9-15.7 pF	1000-0007	E. F. Johnson	187-109-5
C4	Trimmer, Air, Var, 1.9-15.7 pF	1000-0007	E. F. Johnson	187-109-5
C5	Trimmer, Air, Var, 1.9-15.7 pF	1000-0007	E. F. Johnson	187-109-5
C6	Trimmer, Air, Var, 1.9-15.7 pF	1000-0007	E. F. Johnson	187-109-5
C7	Trimmer, Cer, 2-8 pF, 350V	1001-0004	Erie	538-002A-2-8-89A
C8	Mica, 220 pF ±5%, 500V	1002-0029	Elmenco	DM15-F-221J
C9	Mica, 15 pF ±5%, 500V	1002-0001	Elmenco	DM15-C-150J
C10	Mica, 47 pF ±5%, 500V	1002-0012	Elmenco	DM15-E-470J
C11	Mica, 200 pF ±5%, 500V	1002-0042	Elmenco	DM15-F-201J
C12	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C13	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C14	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C15	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C16	Mica, 12 pF ±5%, 500V	1002-0017	Elmenco	DM15-C-120J
	DIODES			
CR1	Si, High Speed	1281-0013	Transitron	1N3064
CR2	Si, High Speed	1281-0013	Transitron	1N3064
CR3	Si, High Speed	1281-0013	Transitron	1N3064
CR4	Si, High Speed	1281-0013	Transitron	1N3064
	RELAYS			
K1	DPDT, 12VDC	1313-0011	Teledyne	712-12
K2	DPDT, 12VDC	1313-0011	Teledyne	712-12
K3	DPDT, 12VDC	1313-0011	Teledyne	712-12
K4	DPDT, 12VDC	1313-0011	Teledyne	712-12
	RESISTORS			
R1	Met. Film, 9.9kΩ ±0.25%, 0.1 W	1074-0035	Dale	MF-1/10-T-9
R2	Met. Film, 6.835kΩ ±0.25%, 0.1 W	1074-0033	Dale	MF-1/10-T-9
R3	Met. Film, 9kΩ ±0.25%, 0.1 W	1074-0034	Dale	MF-1/10-T-9
R4	Met. Film, 9.9kΩ ±0.25%, 0.1 W	1074-0035	Dale	MF-1/10-T-9
R5	Met. Film, 101Ω ±0.25%, 0.1 W	1074-0013	Dale	MF-1/10-T-9
R6	Met. Film, 4.625kΩ ±0.25%, 0.1 W	1074-0031	Dale	MF-1/10-T-9
R7	Met. Film, 1.111kΩ ±0.25%, 0.1 W	1074-0026	Dale	MF-1/10-T-9
R8	Met. Film, 101Ω ±0.25%, 0.1 W	1074-0013	Dale	MF-1/10-T-9



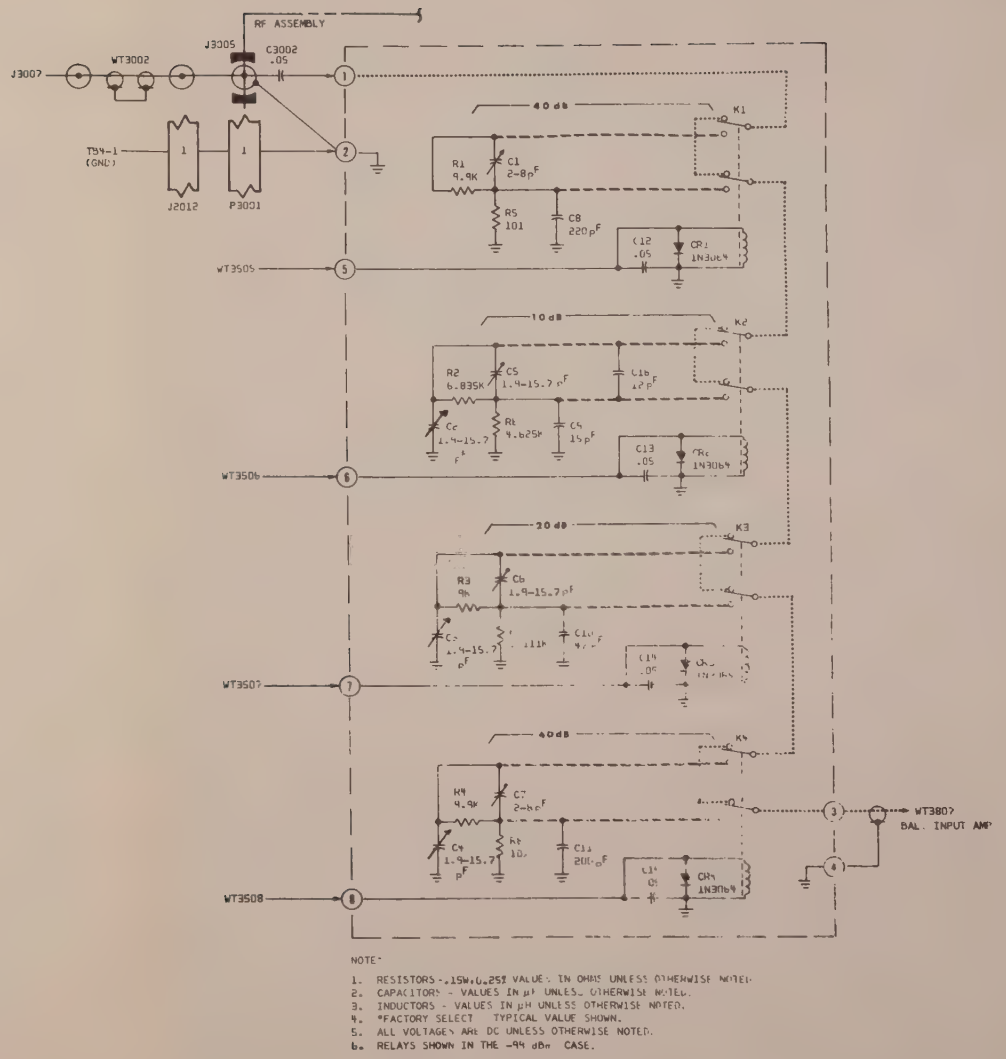
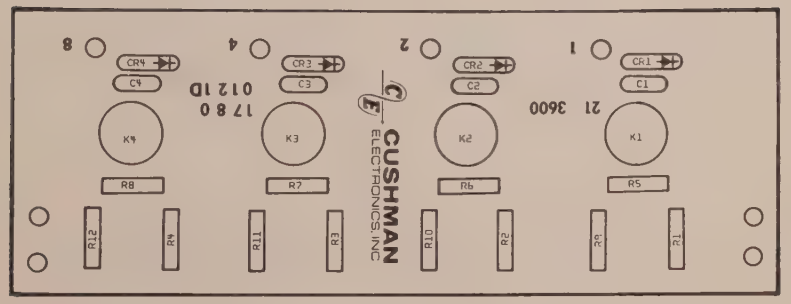
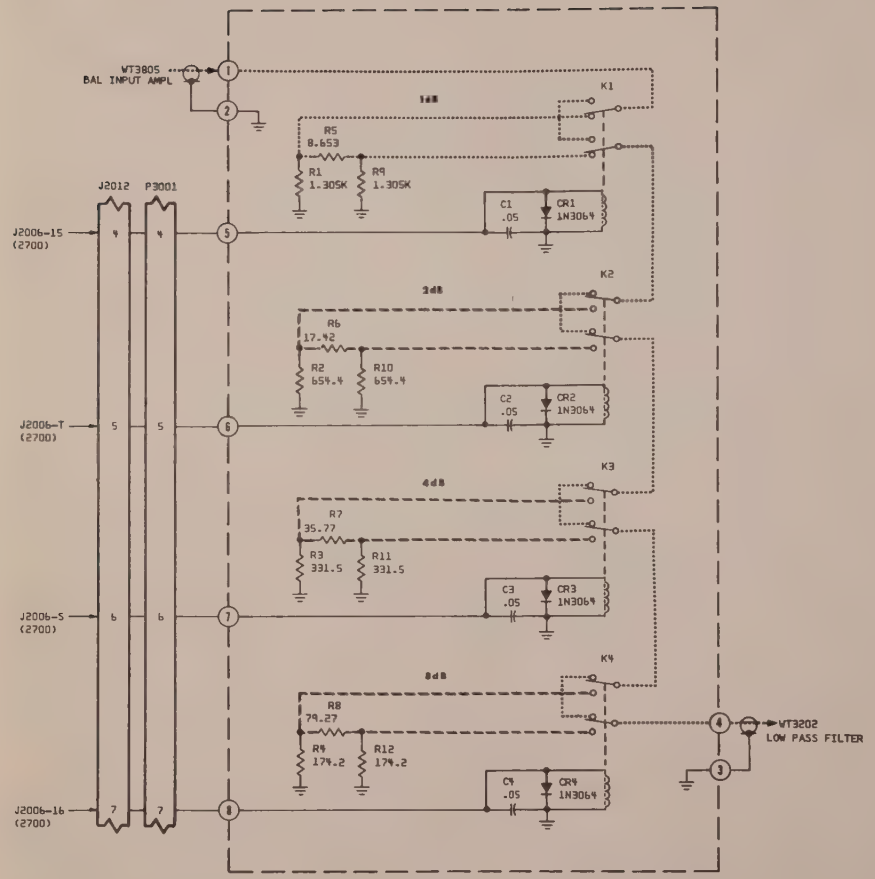


Figure 3-18. Hi-Z Attenuator No. 2, 3500

15 dB ATTENUATOR, 3600

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3600	Board Assembly, 15 dB Attenuator	7001-0067	Cushman	
	Board, Printed Circuit	1780-0121	Cushman	
	CAPACITORS			
C1	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C2	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C3	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
C4	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UO-503Z
	DIODES			
CR1	Si, High Speed	1281-0013	Transitron	1N3064
CR2	Si, High Speed	1281-0013	Transitron	1N3064
CR3	Si, High Speed	1281-0013	Transitron	1N3064
CR4	Si, High Speed	1281-0013	Transitron	1N3064
	RELAYS			
K1	DPDT, 12VDC	1313-0011	Teledyne	712-12
K2	DPDT, 12VDC	1313-0011	Teledyne	712-12
K3	DPDT, 12VDC	1313-0011	Teledyne	712-12
K4	DPDT, 12VDC	1313-0011	Teledyne	712-12
	RESISTORS			
R1	Met. Film, 1.305kΩ ±0.25%, 0.1 W	1074-0028	Dale	MF 1/10-T-9
R2	Met. Film, 654.4Ω ±0.25%, 0.1 W	1074-0024	Dale	MF 1/10-T-9
R3	Met. Film, 331.5Ω ±0.25%, 0.1 W	1074-0022	Dale	MF 1/10-T-9
R4	Met. Film, 174.2Ω ±0.25%, 0.1 W	1074-0019	Dale	MF 1/10-T-9
R5	Met. Film, 8.653Ω ±0.25%, 0.15W	1074-0001	IRC	T-1
R6	Met. Film, 17.42Ω ±0.25%, 0.15W	1074-0002	IRC	T-1
R7	Met. Film, 35.77Ω ±0.25%, 0.1 W	1074-0003	Dale	MF 1/10-T-9
R8	Met. Film, 79.27Ω ±0.25%, 0.1 W	1074-0010	Dale	MF 1/10-T-9
R9	Met. Film, 1.305kΩ ±0.25%, 0.1 W	1074-0028	Dale	MF 1/10-T-9
R10	Met. Film, 654.4Ω ±0.25%, 0.1 W	1074-0024	Dale	MF 1/10-T-9
R11	Met. Film, 331.5Ω ±0.25%, 0.1 W	1074-0022	Dale	MF 1/10-T-9
R12	Met. Film, 174.2Ω ±0.25%, 0.1 W	1074-0019	Dale	MF 1/10-T-9





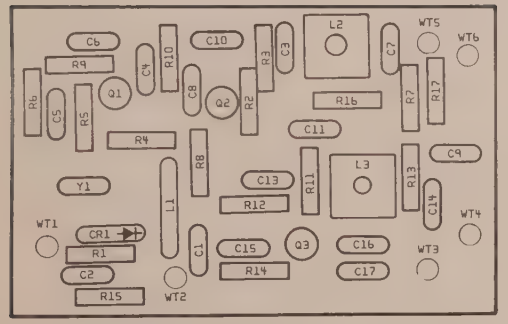
NOTE:

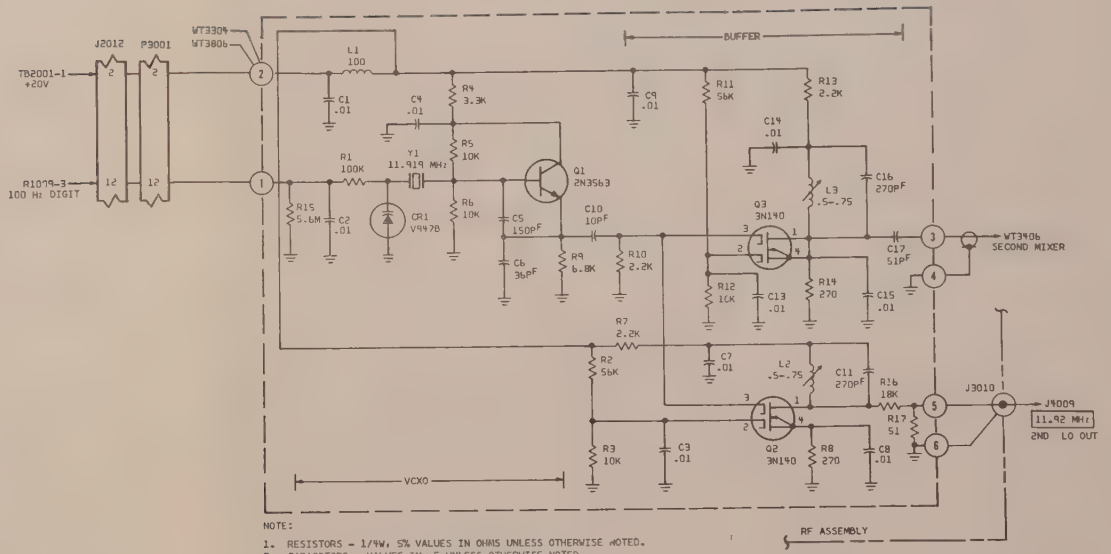
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN µF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN µH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
6. RELAYS SHOWN IN THE -99 dBm CASE.

Figure 3-19. 15 dB Attenuator, 3600

VOLTAGE CONTROLLED CRYSTAL OSCILLATOR. 3700

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3700	Board Assy., Voltage Controlled Crystal Oscillator (VCXO)	7001-0068	Cushman	
	Board, Printed Circuit	1780-0122	Cushman	
	CAPACITORS			
C1	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C2	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C3	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C4	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C5	Mica, 150 pF ±5%, 500V	1002-0021	Elmenco	DM15-F-151J
C6	Mica, 36 pF ±5%, 500V	1002-0041	Elmenco	DM15-E-360J
C7	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C8	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C9	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C10	Mica, 10 pF ±5%, 500V	1002-0016	Elmenco	DM15-C-100J
C11	Mica, 270 pF ±5%, 500V	1002-0031	Elmenco	DM15-F-271J
C12	Not Used			
C13	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C14	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C15	Cer, 0.01 μF +80% -20%, 25V	1005-0013	Erie	5835-504-Y5UD-103Z
C16	Mica, 270 pF ±5%, 500V	1002-0031	Elmenco	DM15-F-271J
C17	Mica, 51 pF ±5%, 500V	1002-0045	Elmenco	DM15-E-510J
	CRYSTAL			
Y1	11.919 MHz	2035-0017	Cushman	
	DIODE			
CR1	Varicap	1281-0019	TRW	V947B
	INDUCTORS			
L1	Choke, RF, 100 μH ±5%	1585-0017	Delevan	1537-76
L2	Var, 0.5 - 0.75 μH	1596-0011	Cushman	
L3	Var, 0.5 - 0.75 μH	1596-0011	Cushman	
	RESISTORS			
R1	Comp, 100kΩ ±5%, 1/4W	1066-1045	Allen-Bradley	CB1045
R2	Comp, 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R3	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R4	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R5	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R6	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R7	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R8	Comp, 270Ω ±5%, 1/4W	1066-2715	Allen-Bradley	CB2715
R9	Comp, 6.8kΩ ±5%, 1/4W	1066-6825	Allen-Bradley	CB6825
R10	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R11	Comp, 56kΩ ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R12	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R13	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R14	Comp, 270Ω ±5%, 1/4W	1066-2715	Allen-Bradley	CB2715
R15	Comp, 5.6 MΩ ±5%, 1/4W	1066-5655	Allen-Bradley	CB5655
R16	Comp, 18kΩ ±5%, 1/4W	1066-1835	Allen-Bradley	CB1835
R17	Comp, 51Ω ±5%, 1/4W	1066-5105	Allen-Bradley	CB5105
	TRANSISTORS			
Q1	Si, NPN	1272-0022	Fairchild	2N3563
Q2	Si, MOS/FET	1272-0028	RCA	3N140
Q3	Si, MOS/FET	1272-0028	RCA	3N140





NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 3-20. Voltage Controlled Crystal Oscillator. 3700

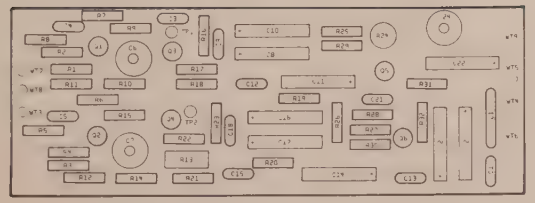
5601-0046

BALANCED INPUT AMPLIFIER. 3800

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3800	Board Assy., Balanced Input Amplifier	7001-0069	Cushman	
	Board, Printed Circuit	1780-0127	Cushman	
	CAPACITORS			
C1	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C2	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C3	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C4	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C5	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C6	Var, Air Trimmer, 1.9-15.7pF	1000-0007	E. F. Johnson	187-109-5
C7	Var, Air Trimmer, 1.9-15.7pF	1000-0007	E. F. Johnson	187-109-5
C8	Elect., 1.5 μF ±10%, 35V	1013-0001	Sprague	150D-155X9035B2
C9	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C10	Elect., 1.5 μF ±10%, 35V	1013-0001	Sprague	150D-155X9035B2
C11	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C12	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C13	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C14	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C15	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C16	Elect., 1.5 μF ±10%, 35V	1013-0001	Sprague	150D-155X9035B2
C17	Elect., 1.5 μF ±10%, 35V	1013-0001	Sprague	150D-155X9035B2
C18	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C19	Not Used			
C20	Elect., 1.0 μF ±10%, 25V	1013-0004	Sprague	30D-105G025BA2
C21	Cer, 0.05 μF +80% -20%, 25V	1005-0014	Erie	5855-505-Y5UD-503Z
C22	Elect., 100 μF +75% -10%, 12V	1013-0011	Sprague	30D-107G012CC2
C23	Not Used			
C24	Var, Air Trimmer, 1.9-15.7pF	1000-0007	E. F. Johnson	187-109-5
	INDUCTOR			
L1	Choke, 100 μH ±5%	1585-0017	Delevan	1537-76
	RESISTORS			
R1	Met. Film, 1.111kΩ ±0.25%, 0.1 W	1074-0026	Dale	MF 1/10-T-9
R2	Met. Film, 9.0kΩ ±0.25%, 0.1 W	1074-0034	Dale	MF 1/10-T-9
R3	Met. Film, 9.0kΩ ±0.25%, 0.1 W	1074-0034	Dale	MF 1/10-T-9
R4	Met. Film, 1.111kΩ ±0.25%, 0.1 W	1074-0026	Dale	MF 1/10-T-9
R5	Comp, 100kΩ ±5%, 1/4W	1066-1045	Allen-Bradley	CB1045
R6	Comp, 220kΩ ±5%, 1/4W	1066-2245	Allen-Bradley	CB2245
R7	Comp, 220kΩ ±5%, 1/4W	1066-2245	Allen-Bradley	CB2245
R8	Comp, 100kΩ ±5%, 1/4W	1066-1045	Allen-Bradley	CB1045
R9	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R10	Comp, 330Ω ±5%, 1/4W	1066-3315	Allen-Bradley	CB3315
R11	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R12	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R13	Pot., 200Ω, ±10%, 1/2W	1215-0016	Helitrim	66WR200
R14	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley	CB2215
R15	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R16	Comp, 1K ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R17	Comp, 10Ω ±5%, 1/4W	1066-1005	Allen-Bradley	CB1005
R18	Comp, 910Ω ±5%, 1/4W	1066-9115	Allen-Bradley	CB9115
R19	Comp, 120Ω ±5%, 1/4W	1066-1215	Allen-Bradley	CB1215
R20	Comp, 120Ω ±5%, 1/4W	1066-1215	Allen-Bradley	CB1215
R21	Comp, 910Ω ±5%, 1/4W	1066-9115	Allen-Bradley	CB9115
R22	Comp, 10Ω ±5%, 1/4W	1066-1005	Allen-Bradley	CB1005
R23	Comp, 1K ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025

BALANCED INPUT AMPLIFIER (cont). 3800

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R24	Pot., Cer, Met. 5kΩ ±10%, 1/2W	1200-0021	Helitrim	62P-R5K
R25	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R26	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley	CB5625
R27	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley	CB5625
R28	Comp, 120Ω ±5%, 1/4W	1066-1215	Allen-Bradley	CB1215
R29	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R30	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R31	Comp, 75Ω ±5%, 1/4W	1066-7505	Allen-Bradley	CB7505
R32	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
	TRANSISTORS			
Q1	Si, MOS/FET, N-Channel	1272-0028	RCA	3N140
Q2	Si, MOS/FET, N-Channel	1272-0028	RCA	3N140
Q3	Si, PNP	1272-0023	Fairchild	2N4121
Q4	Si, PNP	1272-0023	Fairchild	2N4121
Q5	Si, NPN	1272-0032	Motorola	2N3904
Q6	Si, PNP	1272-0037	Motorola	2N3906



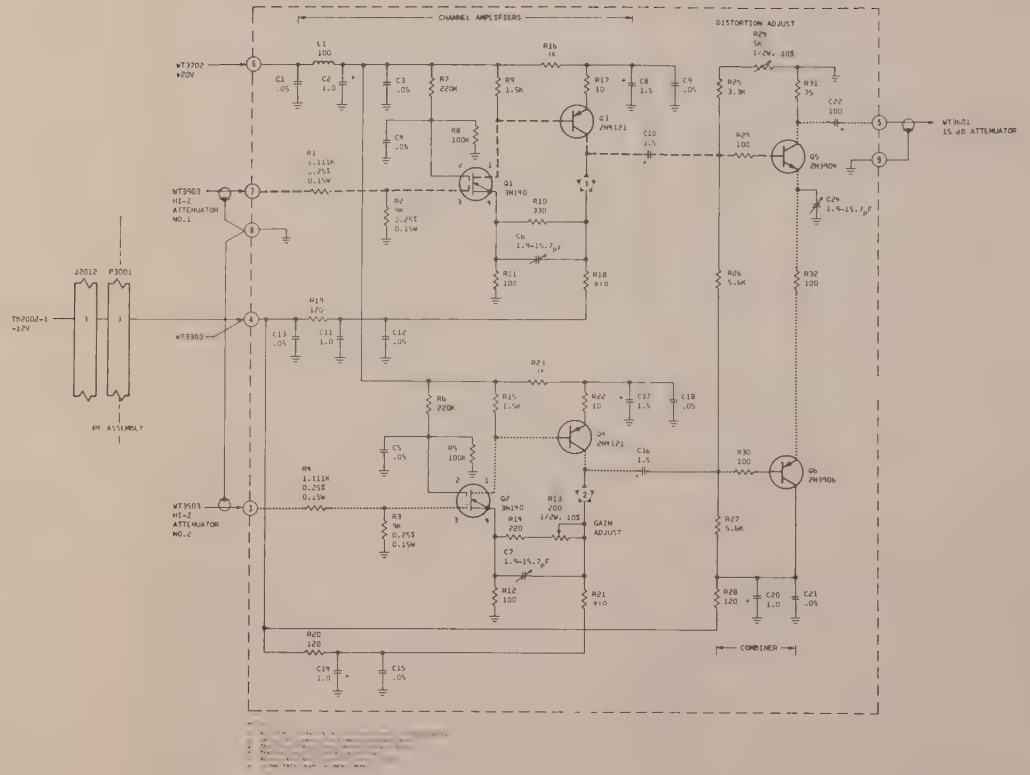
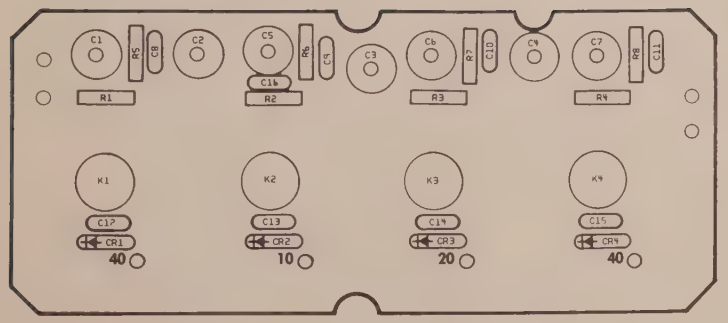


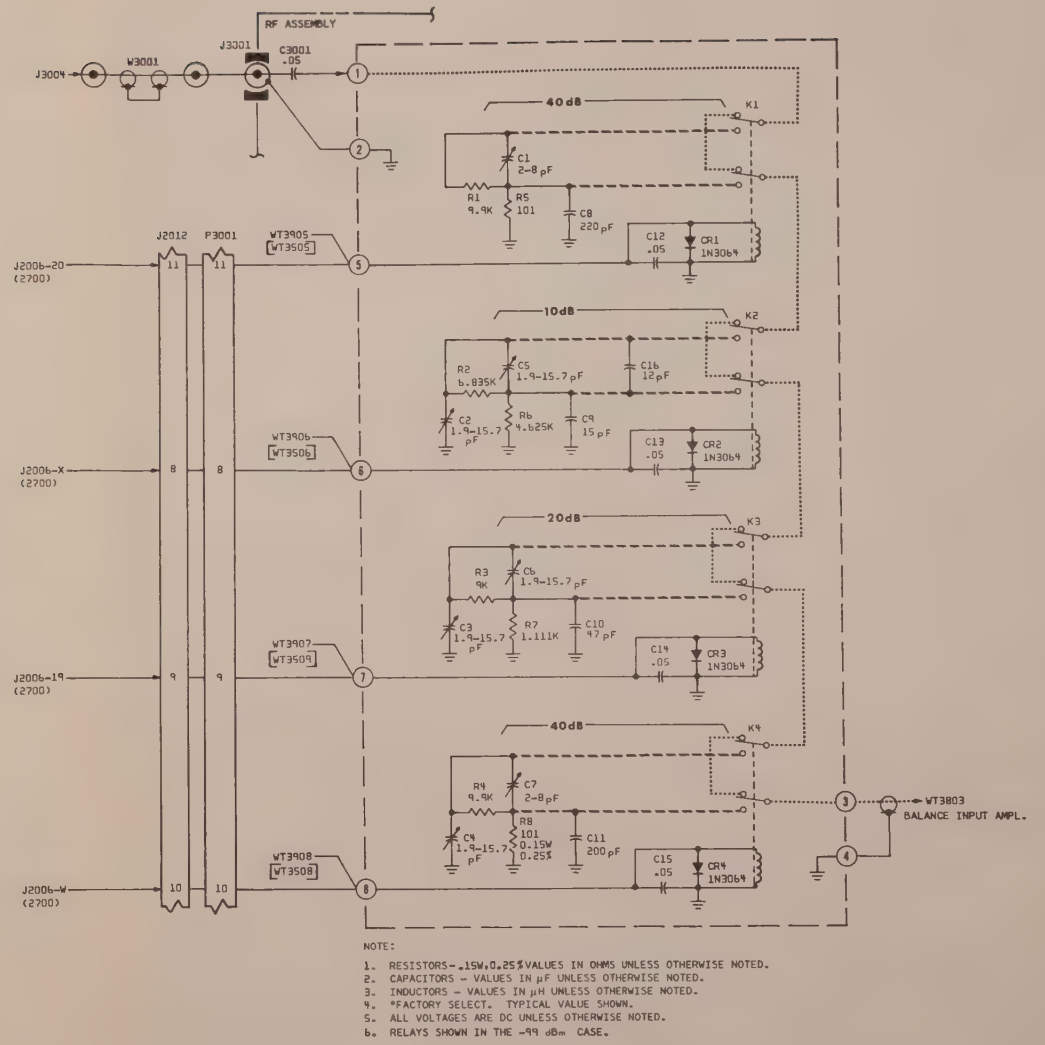
Figure 3-21. Balanced Input Amplifier, 3800

5601-0046

HI-Z ATTENUATOR No. 1. 3900

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
3900	Board Assy., Hi-Z Attenuator No. 1	7001-0138	Cushman	
	Board, Printed Circuit	1780-0134	Cushman	
	Same as Hi-Z Attenuator No. 2 (3500)			





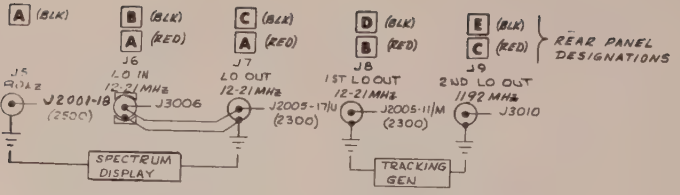
NOTE:

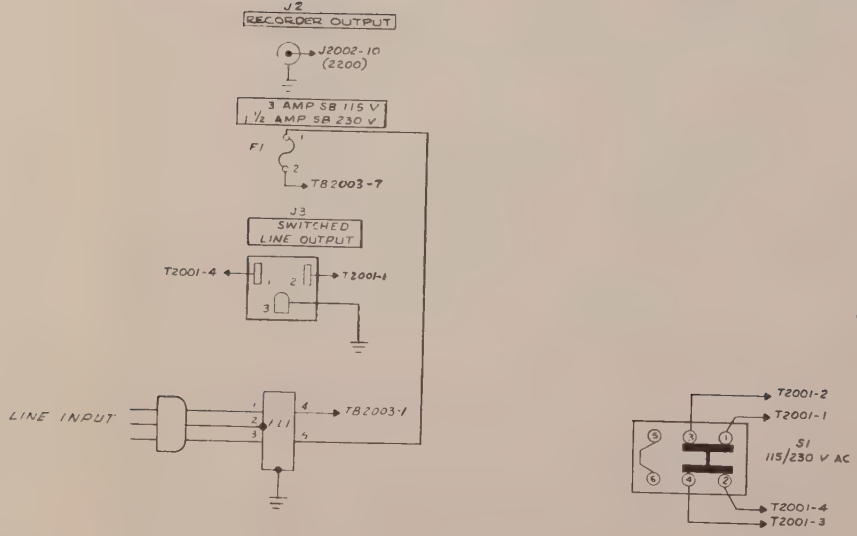
1. RESISTORS - .15W, 0.25% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN µF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN µH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
6. RELAYS SHOWN IN THE -99 dBm CASE.

Figure 3-22. Hi-Z Attenuator No. 1. 3900

REAR PANEL. 4000

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
4000	Assembly, Rear Panel	7003-0068	Cushman	
	Rear Panel	2800-0083	Cushman	
	FUSE			
F1	Slo-Blo, 3 Amp, 3 AG	1955-0012	Littelfuse	313003
	FUSEHOLDER			
XF4001	3 AG, Bayonet Knob	1965-0001	Littelfuse	342012
	JACKS			
J1	BNC	2536-0010	Kings	KC79-35
J2	BNC	2536-0010	Kings	KC79-35
J3	Outlet, 3-wire	2535-0025	Waber Electronics	3017
J4/FL1	3-contact, Flush Mt., Recpt & Filter, RF-1 Line	p/o2535-0024	Components Corp.	5A-2
J5	BNC	2536-0010	Kings	KC79-35
J6	BNC Isolated Jack	2536-0052	Kings	KC79-67
J7	BNC	2536-0010	Kings	KC79-35
J8	BNC	2536-0010	Kings	KC79-35
J9	BNC	2536-0010	Kings	KC79-35





NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 3-23. Rear Panel Interconnection Diagram. 4000

MODEL 211 BRIDGING PROBE

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	Bridging Board, P.C. Board Assy.	7001-0235	Cushman	
	P.C. Board, Bare	1780-0200	Cushman	
	CAPACITORS			
C1	Cer, .01 μf +80 - 20%, 500V	1005-0094	Bel.	GIX 615
C2	Cer Tubular, .47 pf ± .25 pf, 500V	1005-0095	Erie	301-000-C0H0-478C
C3	Cer, .01 μf +80 - 20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C4	Tant, 10 μf +50 - 20%, 35V	1011-0006	ITT	Tag 10/35-20
C5	Cer, .01 μf +80 - 20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C6	Tant, 10 μf +50 - 20%, 35V	1011-0006	ITT	Tag 10/35-20
C7	Tant, 10 μf +50 - 20%, 35V	1011-0006	ITT	Tag 10/35-20
C8	Cer, .1 μf ± 10%, 100V	1005-0064	Aerovox	CK06BX104K
C9	Cer, .1 μf ± 10%, 100V	1005-0064	Aerovox	CK06BX104K
C10	Cer, .01 μf +80 - 20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C11	Tant, 10 μf +50 - 20%, 35V	1011-0006	ITT	Tag 10/35-20
	COILS			
L1	Choke, 100 μH ± 5%, Molded	1585-0017	Delevan	1537-76
	DIODES			
CR1	Si, Zener, 9.1V ± 5%, 1W	1281-0027	IRC	IN4739A
CR2	Zener, IN4731A	1281-0025	I.R.	IN4731A
CR3	Diode, IN3064	1281-0013	Teledyne	IN3064
CR4	Diode, IN3064	1281-0013	Teledyne	IN3064
	RESISTORS			
R1	Comp, 1M ± 5%, 1/4W	1066-1055	Allen-Bradley	CB1055
R2	Comp, 330K ± 5%, 1/4W	1066-3345	Allen-Bradley	CB3345
R3	Comp, 240K ± 5%, 1/4W	1066-2445	Allen-Bradley	CB2445
R4	Comp, 1K ± 5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R5	Metal Film, 1K ± 1%, 1/8W	1075-0037	Dale	MFF 1/8 T1
R6	Comp, 1K ± 5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R7	Comp, 1K ± 5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R8	Metal Film, 887Ω ± 1%, 1/8W	1075-0022	Dale	MFF 1/8 T1
R9	Pot, 500Ω ± 20%, 1/2W, 4 turn cermet	1203-0063	Bourns	3339H-1-501
R10	Comp, 510Ω ± 5%, 1/4W	1066-5115	Allen-Bradley	CB5115
R11	Metal Film, 75Ω ± 1%, 1/8W	1075-0035	Dale	MFF 1/8 T1
	TRANSISTORS			
Q1	Si, NPN, 2N5962	1272-0059	Fairchild	2N5962
Q2	Si, PNP, 2N5208	1272-0069	Motorola	2N5208
Q3	Si, NPN, 25V, MPS 6543	1271-0008	Motorola	2N6543

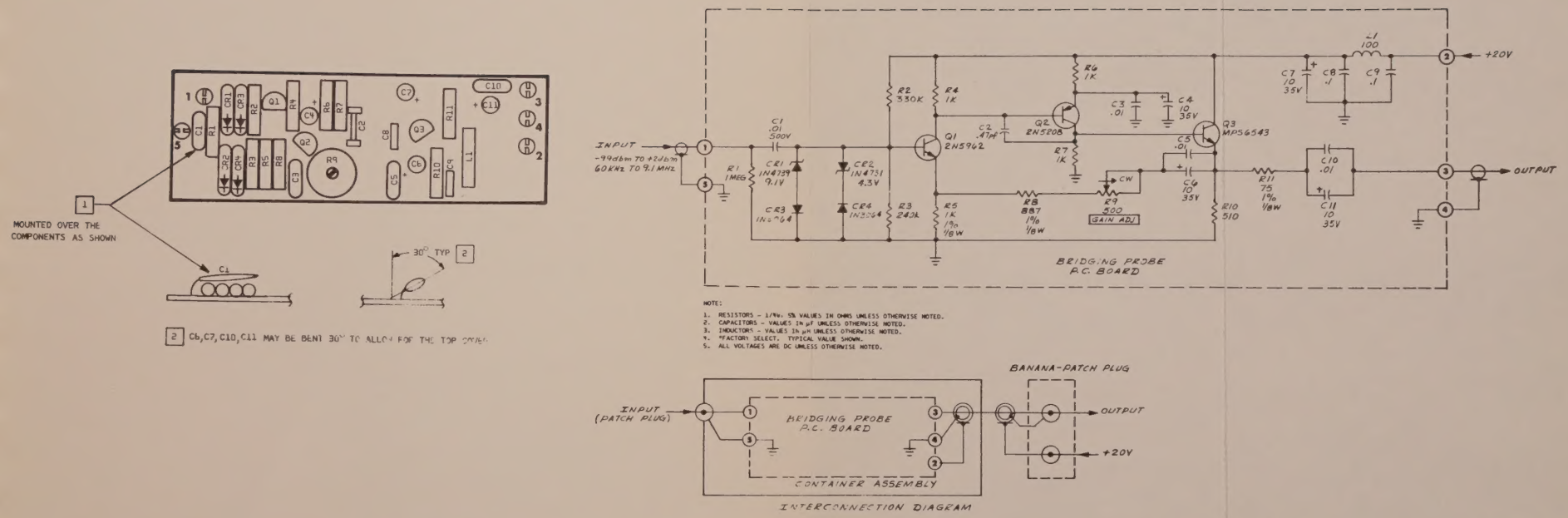


Figure 3-24. Model 211 Bridging Probe

2450 North First Street San Jose,Ca 95131
Telephone: Area Code 408-263-8100

www.manualsplus.com
1007013